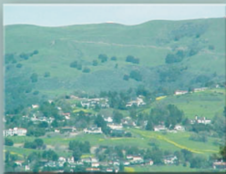
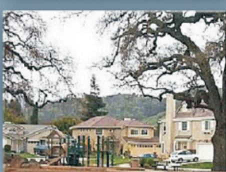




mh102r3-6179.psd

CITY OF MORGAN HILL

Storm Drainage System Master Plan

January 2002

carollo engineers

REGISTERED PROFESSIONAL ENGINEER
THOMAS S. KALKMAN
No. 40131
Exp. 6/25/02
Thomas S Kalkman 5/8/02
CIVIL
STATE OF CALIFORNIA

carollo engineers

City of Morgan Hill

STORM DRAINAGE SYSTEM

MASTER PLAN

January 2002

REGISTERED PROFESSIONAL ENGINEER
ANTOINE A.
No. C-041682
Exp. 03/31/04
CIVIL
STATE OF CALIFORNIA

carollo engineers

2700 YGNACIO VALLEY ROAD, SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 932-1710
H:\Final\MorganHill_FNO\6179A00\TO3\TOC.doc

January 8, 2002
6179A.00 T03

City of Morgan Hill
17555 Peak Avenue
Morgan Hill, California 95037-4128

Attention: Mr. Jim Ashcraft, Director of Public Works/City Engineer

Subject: Storm Drainage Master Plan - Final Report

Dear Mr. Ashcraft:

We are pleased to submit the final report for the City of Morgan Hill Storm Drainage System Master Plan. The report presents master planning assumptions, existing storm drainage system capacity evaluation, recommended facility improvements, and a capital improvement program to the planning horizon year 2020. The report is organized as follows:

Chapter 1 - Introduction
Chapter 2 - Planning Area Characteristics
Chapter 3 - Planning and Design Criteria
Chapter 4 - Existing System and Hydraulic Model
Chapter 5 - Evaluation and Proposed Improvements
Chapter 6 - Capital Improvement Program

We would like to extend our thanks to you, Ms. Alice Tulloch, Ray Dellanini, Julie Behzad, and other City staff whose courtesy and cooperation were valuable components in completing this study and producing this report.

Sincerely,

CAROLLO ENGINEERS, P.C.

Thomas S Kalkman

Tony Akel

Thomas S. Kalkman, P.E.
Principal

Tony A. Akel, P.E.

TSK/TAA:cjp

Enclosures: Final Report

City of Merced

STORM DRAINAGE SYSTEM

MASTER PLAN

TABLE OF CONTENTS

Page No.

CHAPTER 4 – EXISTING SYSTEM AND HYDROLIC MODEL

CHAPTER 5 – STORM DRAINAGE SYSTEM EVALUATION AND PROPOSED IMPROVEMENTS

CHAPTER 6 – CAPITAL IMPROVEMENT PROGRAM

LIST OF TABLES

LIST OF FIGURES

Executive Summary

STORM DRAINAGE SYSTEM MASTER PLAN

This executive summary presents a brief background of the City's storm drainage system, the need for this storm drainage master plan, the proposed improvements to mitigate existing capacity deficiencies, and the proposed expansion improvements. Listed at the end of this chapter is a summary of the capital improvement program costs, through the planning horizon year of 2020.

ES.1 STUDY OBJECTIVE

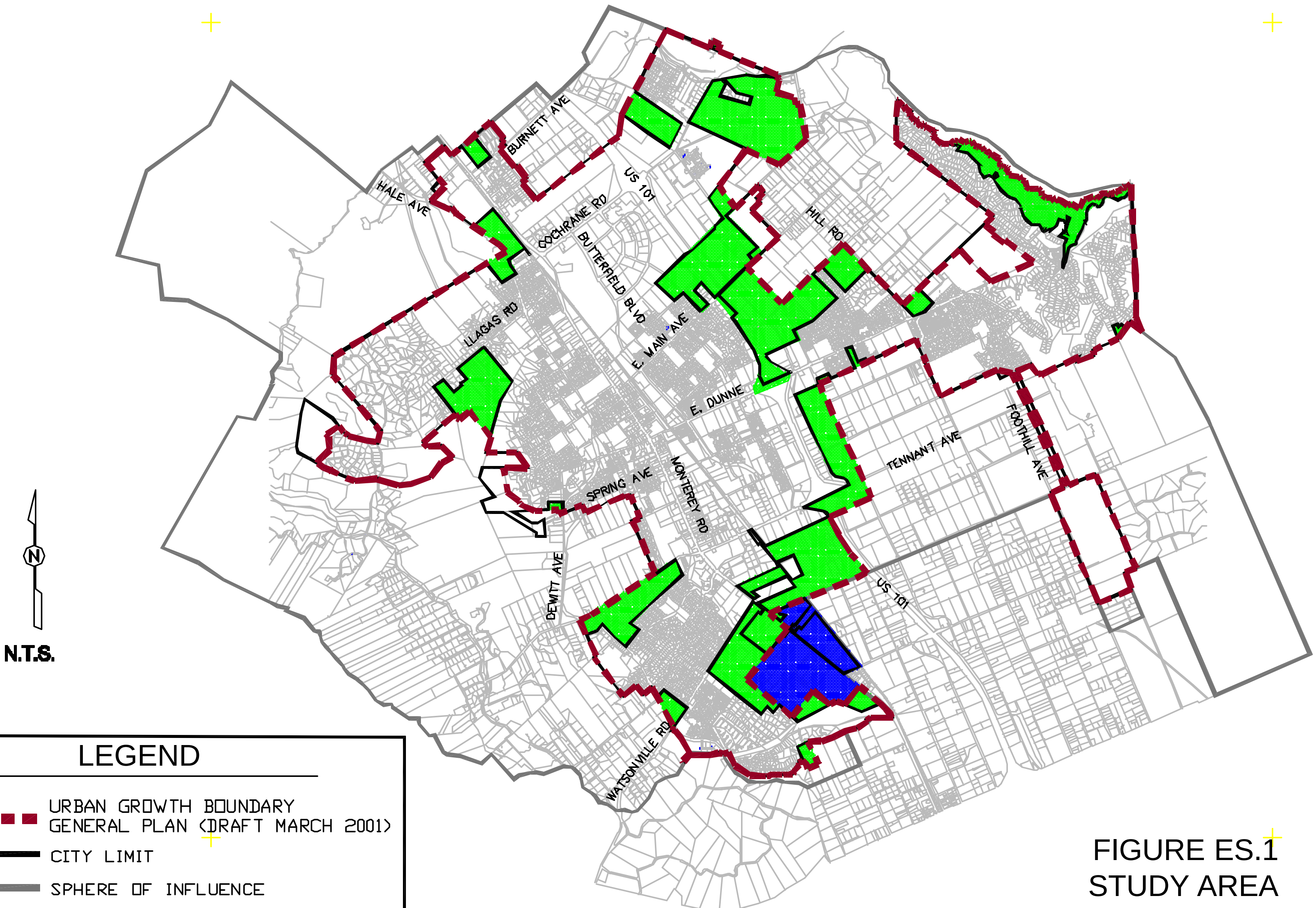
Recognizing the importance of planning, developing, and financing storm drainage system facilities to provide reliable and enhanced service for existing customers and to serve anticipated growth, the City initiated the preparation of this storm drainage system master planning study. The Storm Drainage System Master Plan study has been coordinated with the preparation of the Water System Master Plan and the Sewer System Master Plan, which were concurrently completed by Carollo Engineers.

The objective of the study included the following tasks:

- Establish storm drainage system design and planning criteria.
- Evaluate the existing storm drainage system using computer hydraulic modeling.
- Summarize existing system deficiencies and propose improvements to enhance system reliability.
- Recommend improvements needed to service anticipated future growth.
- Develop a Capital Improvement Program with a planning horizon year of 2020.

ES.2 STUDY AREA

The 2001 General Plan Update developed by Crawford Multari & Clark Associates (Draft report dated March 2001), identifies the current boundaries of the Urban Growth Boundary (UGB), as shown on Figure ES.1. The City's water distribution master plan identifies the infrastructure necessary to service developed lands within the UGB. According to the General Plan, areas outside the UGB are intended to remain rural and unincorporated for the next 20 years.



LEGEND

- URBAN GROWTH BOUNDARY GENERAL PLAN (DRAFT MARCH 2001)
- CITY LIMIT
- SPHERE OF INFLUENCE
- EXPANSION AREAS
- AREA ADDED TO GENERAL PLAN (ADOPTED JULY 2001)

FIGURE ES.1
STUDY AREA

CITY OF MORGAN HILL
MASTER PLAN

H:\Client\MorganHill_FND\6179A.00\10-Reports\Graphics\ES-11211

The City's General Plan Update assumes that the current residential growth control will remain through the planning horizon year of 2020, yielding an average annual growth rate over the next 20 years of 1.8 percent. The General Plan Update further projects population ceilings of 38,800 and 48,000 for the years 2010 and 2020, respectively.

ES.3 STORM DRAINAGE SYSTEM OVERVIEW

The City of Morgan Hill's storm drainage system consists of a combination of curb and gutter facilities, curb inlets, underground pipelines, and bubblers draining to the nearest creek or to manmade natural retention areas. It has been reported that the storm drainage improvements constructed before 1982 were designed without the benefit of a City wide master plan, and therefore connected to the nearest creek with no known consideration of the downstream impact.

Over the past decade, City staff have assertively required developers to construct storm drainage facilities (pipelines, ponds, pump station), as part of their proposed developments, and in compliance with the 1988 Plan. Additionally, since the adoption of the 1982 Subdivision Design Standards, new subdivisions have been required to construct interim site retention and detention ponds to limit the amount of storm runoff to the pre-development peak rates.

ES.4 DESIGN STORMS

The Morgan Hill wet season occurs from late October through early April, although the largest storm events occurred in the December-February period. Typically, precipitation amounts from storms originating in the Pacific Ocean reach their maximum at the higher elevations of the coastal ranges and decrease with the lower elevations of the inland valleys. The mean annual precipitation was greatest on the hills west of the City (maximum 24 inches) and reached a minimum (17.5 inches) on the valley floor at the southeast part of the City.

Two design storms were used for the evaluation of Morgan Hill's existing drainage system, and for the design of future drainage facilities. The 10-year event was used for evaluating conveyance facilities while the 100-year event was used for evaluating the existing ponds. The 10- and 100-year recurrence intervals have become standard selections in most locations in California because they provide a balance between level of service and affordability and provide reasonable standards of care that is most defensible in court.

ES.4.1 Conveyance Facilities

The 24-hour, 10-year design storm was used for sizing of conveyance facilities for drainable areas. This storm was consistent with the current City of Morgan Hill design standards. The

24-hour, 100-year design storm was used to determine if street flooding exceeds one foot in depth and could flood buildings or create serious safety hazards.

ES.4.2 Detention and Retention Basins

The City's existing design standards stipulate that areas, larger than one acre, shall tie on-site drainage into the City's storm drainage system. Ponding basins on private or public property shall be designed for a 24-hour, 25-year storm event if a reasonable outlet is provided (detention). If no disposal other than evaporation, percolation irrigation is provided (retention); a 24-hour, 100-year storm shall be used.

For analysis purposes, this master plan used the 24-hour 100-year design storm for evaluating both retention and detention basins. This storm is consistent with the SCVWD Hydrology Procedures manual. The 100-year design flood, as used by FEMA, provided the boundary conditions for main channel receiving systems.

ES.5 STORM DRAINAGE SYSTEM EVALUATION

The City of Morgan Hill is divided into several hydrologically distinct drainage areas. Each drainage area has a system of conveyance facilities, pumps, and detention basins to collect and dispose the runoff. The storm water runoff from these areas is collected and ultimately discharged into creeks that flow through the City and are tributary to either of Monterey Bay or San Francisco Bay. The drainage areas include Coyote Creek, Fisher Creek, Tennant Creek, Madrone Channel, Butterfield Channel, West Little Llagas Creek, and Llagas Creek. Each drainage area has a system of conveyance facilities, pumps, and basins to collect and dispose the runoff.

Many computer models are available to simulate hydrologic and hydraulic conditions in the City's storm drainage system. The existing system was evaluated using two separate computer models that analyzed the hydrology and hydraulics. Hydrologic analysis of the Morgan Hill drainage system was performed using the mathematical watershed model HEC-1 (U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package, 1991) and the hydraulic model EPA SWMM-Extran (Environmental Protection Agency, Stormwater Management Model, Extended Transport Module).

Based on the evaluation criteria discussed in this report, existing and projected design storms were simulated to evaluate the capacity adequacy of the existing storm drainage system. Estimates of main channel capacity were calculated based on the as-builts or surveyed channel cross sections and gradients, and were used for routing purposes. It was assumed that 100-year water surface elevations for main channels were between zero and one foot below existing ground level, including the influence of future main channel system improvements. This assumption applied to West Little Llagas, Butterfield, Madrone and Tennant main channels. These water levels were used for establishing the downstream boundary conditions for the modeled storm drainage system.

ES.6 CONCLUSIONS

The analysis of the City's storm drainage system indicates the City has a vast system of retention and detention ponds that were exceptionally well planned to meet the needs of the City's drainage needs. The project improvements proposed in this master plan are needed to enhance the City's drainage system capabilities as new areas develop. City staff has been planning the construction of many of these storm drainage enhancements.

ES.6.1 Channel Capacities

The analysis indicates that the existing or proposed design capacities for Butterfield Channel, West Little Llagas Creek Channel, Madrone Channel and Tennant Channel will accommodate 100-year design storms for the buildout land use conditions, as established in the City's General Plan. The analysis also indicates that backwater levels in Llagas Creek and Coyote Creek did not significantly influence the storm drainage system during the 100-year design storm.

This report also assumes that certain main channel improvements be completed by 2020. These included improvements to West Little Llagas Creek and Butterfield Channel as presently designed. Butterfield Channel eventually terminates in a regional retention pond, since the US Corps of Engineers Llagas Creek flood control plan does not allow for future flow increases from Butterfield Channel.

ES.6.2 Pipe Drainage Capacities

The analysis results for the modeled pipe segments are summarized in detail in Appendix A. The appendix lists the existing pipe capacities and the required sizes for meeting 10-year and 100-year storm events.

ES.6.3 Retention and Detention Ponds

The performance of existing detention ponds was evaluated using the 100-year event during projected future land use condition. Most of the detention ponds provided useful 100-year flow storage and attenuation. Ponds with attenuation values below 3 cfs did not provide significant storage.

ES.6.4 Pump Stations

There are two existing major active pump stations and one sump pump station in the City's storm drainage system. The first is located at Morgan Hill Business Park (Fisher Subbasin) and pumps to Fisher Channel. The second is at the Concord Circle (West Little Llagas Creek Subbasin) and pumps to Little Llagas Creek. The third pump station empties a sump condition at the Monterey Road railroad crossing. The analysis indicates that the existing pond capacities at both major pump stations are adequate for the 100-year future design condition, except when receiving channels were full.

ES.7 RECOMMENDATIONS

The vast majority of the proposed projects consist of new or increased capacity pipelines and new ponds in currently undeveloped areas. These proposed improvements, which are discussed in detail in the report, are phased to provide capacity enhancements to the distribution system before the anticipated developments. This section provides a summary of the storm drainage enhancements.

- Construct the planned Butterfield Detention Basin.
- Continue with the well planned strategy of constructing retention and detention ponds for newly developed areas.
- Lower Tennant Creek, outside of the City limits, will eventually require improvement downstream to Llagas Creek. This improvement needs to be coordinated with the Santa Clara Valley Water District (SCVWD) and may require a retention pond.
- Lower Fisher Creek requires improvement and coordination with SCVWD at the northern City limit.
- The Llagas Hills Estates pond, located in the West Little Llagas Creek Basin, require modification to alleviate downstream potential flooding. Increased capacity will mitigate excess street flows downstream near Teresa Lane.
- It is recommended that operational modifications be implemented at both major stormwater pump stations. The City may wish to consider managing the time of discharging back to the stream via a telemetry system.

ES.8 CAPITAL IMPROVEMENT PROGRAM

The cost estimates presented in the Capital Improvement Program have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of projects will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as: preliminary alignments generation, investigation of alternative routings, and detailed utility and topography surveys.

Knowledge about site-specific conditions for each proposed project is limited at the master planning stage, therefore the Estimated Construction Costs include a 30 percent contingency to account for unforeseen events and unknown field conditions. The Capital Improvement Costs also include an additional 30 percent (applied to the Estimated Construction costs) for project-related costs, comprising of engineering, administration, construction inspection, and legal costs.

Table ES.1 Capital Improvement Program
Storm Drainage System Master Plan
City of Morgan Hill

Planning Period	Year	Capital Cost	Current Users	Future Users
Short-Term Improvements	2002-2003	$1,472,000	$497,000	$975,000
	2003-2004	$2,342,000	$0	$2,342,000
	2004-2005	$4,333,000	$1,641,500	$2,691,500
Intermediate-Term Improvements	2005-2010	$4,816,000	$3,432,000	$1,384,000
Long-Term Improvements	2010-2020	$15,049,000	$1,922,000	$13,127,000
Total		$28,012,000	$7,492,500	$20,519,500

Chapter 1

INTRODUCTION

This chapter presents the need for this storm drainage system master plan and the objectives of the study. A list of abbreviations is also provided to assist the reader in understanding the information presented.

1.1 BACKGROUND

The City of Morgan Hill (Figure 1.1) operates its own storm drainage system within City Limits, however the drainage system flows into existing channels and detention ponds owned and operated by the Santa Clara Valley Water District (SCVWD). The previous storm drainage system master plan was completed in March 1988 (1988 Plan) and included a review of the storm drainage system, an examination of the hydrology for Fisher Creek and Tennant Creek prepared by Santa Clara Valley Water District, a determination of the hydrology and hydraulics criteria, and a review of the storm drainage fee schedule. The 1988 Plan was based on planning assumptions and operational conditions that have since changed.

In 1996, the City Council adopted a long-term Urban Growth Boundary (UGB), which identifies lands intended for future urbanization within the Sphere of Influence (SOI). In the fall of 1998, the City appointed a General Task Force to oversee major revisions of the Morgan Hill General Plan. The Task Force defined an expanded set of community goals and proposed changes to the 1996 General Plan that were summarized in the General Plan Update (October 1999). Subsequently, the City embarked on a more comprehensive update to the General Plan and retained the services of the firm Crawford, Multari, & Clark Associates (CMCA). A draft version of the General Plan, dated March 2001, was released by CMCA.

1.2 SCOPE AND AUTHORIZATION

Recognizing the importance of planning, developing, and financing storm drainage system facilities to provide reliable and enhanced service for existing customers and to serve anticipated growth, the City initiated the preparation of this storm drainage system master planning study.

On December 4, 2000, The City authorized Carollo Engineers to prepare this storm drainage system master plan study which included the following tasks:

- Establish storm drainage system design and planning criteria.
- Perform a hydrologic analysis using a watershed model.
- Evaluate the existing storm drainage system using computer hydraulic modeling.
- Summarize existing system deficiencies and propose improvements to enhance system reliability.

Figure 1.1
REGIONAL LOCATION MAP
CITY OF MORGAN HILL
MASTER PLAN

carollo engineers

- Recommend improvements needed to service anticipated future growth.
- Develop a Capital Improvement Program with a planning horizon year of 2020.

The study includes several planning assumptions that are documented in this report. Should future planning conditions deviate from the assumptions stated in this master plan (i.e., accelerated growth, more intense developments, supply source modifications, etc.), revisions and adjustments to the master plan recommendations would be necessary.

1.3 REPORT ORGANIZATION

The storm drainage system master plan report contains seven chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

Chapter 1 - Introduction. This chapter presents the need for this storm drainage system master plan and the objectives of the study. A list of abbreviations is also provided to assist the reader in understanding the information presented.

Chapter 2 - Planning Area Characteristics. This chapter presents a discussion of this study's planning area characteristics, defining the land use classifications and summarizing the historical population trends. Projected populations were used for estimating future water requirements and were based on the recent update to the General Plan.

Chapter 3 - Planning and Design Criteria. The City's storm drainage facilities were evaluated based on the analysis and design criteria defined in this chapter. Precipitation characteristics, design storm duration and frequency, and impervious vs. pervious surfaces were reviewed to perform the hydrologic analysis on the system. The developed criteria address the storm drainage system capacity, the performance of the detention ponds, and main channel capacities.

Chapter 4 - Existing System and Hydraulic Model. This chapter presents an overview of the City's storm drainage facilities. The chapter also describes the development of the City's Storm Drainage Hydrologic and Hydraulic Models. These models were used for identifying existing system deficiencies and for recommending enhancements.

Chapter 5 - Storm Drainage System Evaluation and Proposed Improvements. This chapter presents the results of the capacity evaluation of the storm drainage system. The chapter also presents improvements to mitigate existing system deficiencies and for servicing future growth. These improvements are recommended based on the system's technical requirements, cost effectiveness, and operational reliability.

Chapter 6 - Capital Improvement Program. This chapter presents the recommended Capital Improvement Program (CIP) for the City of Morgan Hill storm drainage system. The program is based on the evaluation of the City's storm drainage system, and on the recommended projects described in the previous chapters. The CIP has been staged to the planning horizon year of 2020.

1.4 ACKNOWLEDGMENTS

Carollo Engineers wishes to acknowledge and thank Mr. Jim Ashcraft, Director of Public Works and City Engineer; Mrs. Alice Tulloch, Project Manager; Mr. Ray Dellanini, Utility Systems Manager; and Ms. Julie Behzad, Associate Engineer. Their own and their staff's cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report.

1.5 ABBREVIATIONS AND DEFINITIONS

To conserve space and to improve readability, the following abbreviations are used in this report.

CIP	capital improvement program
City	City of Morgan Hill
cfs	cubic feet per second
CMCA	Crawford Multari & Clark Associates
County	County of Santa Clara
DDF	depth-duration-frequency
DOF	Department of Finance
ENR CCI	Engineering News Records Construction Cost Index
EPA	Environmental Protection Agency
EXTRAN	Stormwater Management Model - Extended Transport Module developed by EPA
FEMA	Federal Emergency Management Agency
HEC-1	Mathematical Watershed Model developed by US Army Corps of Engineers
HPRE	preprocessor computer program
LF	linear feet
ROW	right-of-way
SCS	Soil Conservation Service (presently National Resource Conservation Service)
SCVWD	Santa Clara Valley Water District
SOI	sphere of influence
SPRR	Southern Pacific Railroad
SWMM	Stormwater Management Model developed by EPA
UGB	Urban Growth Boundary
USCOE	U.S. Army Corps of Engineers

PLANNING AREA CHARACTERISTICS

This chapter presents a discussion of this study's planning area characteristics, defining the land use classifications and summarizing the historical population trends. Projected populations were used for estimating future water requirements and were based on the recent update to the General Plan.

2.1 STUDY AREA

The City of Morgan Hill is located in the Santa Clara Valley, approximately 12 miles south of the City of San Jose and 10 miles north of the City of Gilroy. The City is bisected by State Highway 99 in a north-south direction. In 1996, the City Council adopted a long-term Urban Growth Boundary (UGB), which identifies lands intended for future urbanization within the Sphere of Influence (SOI).

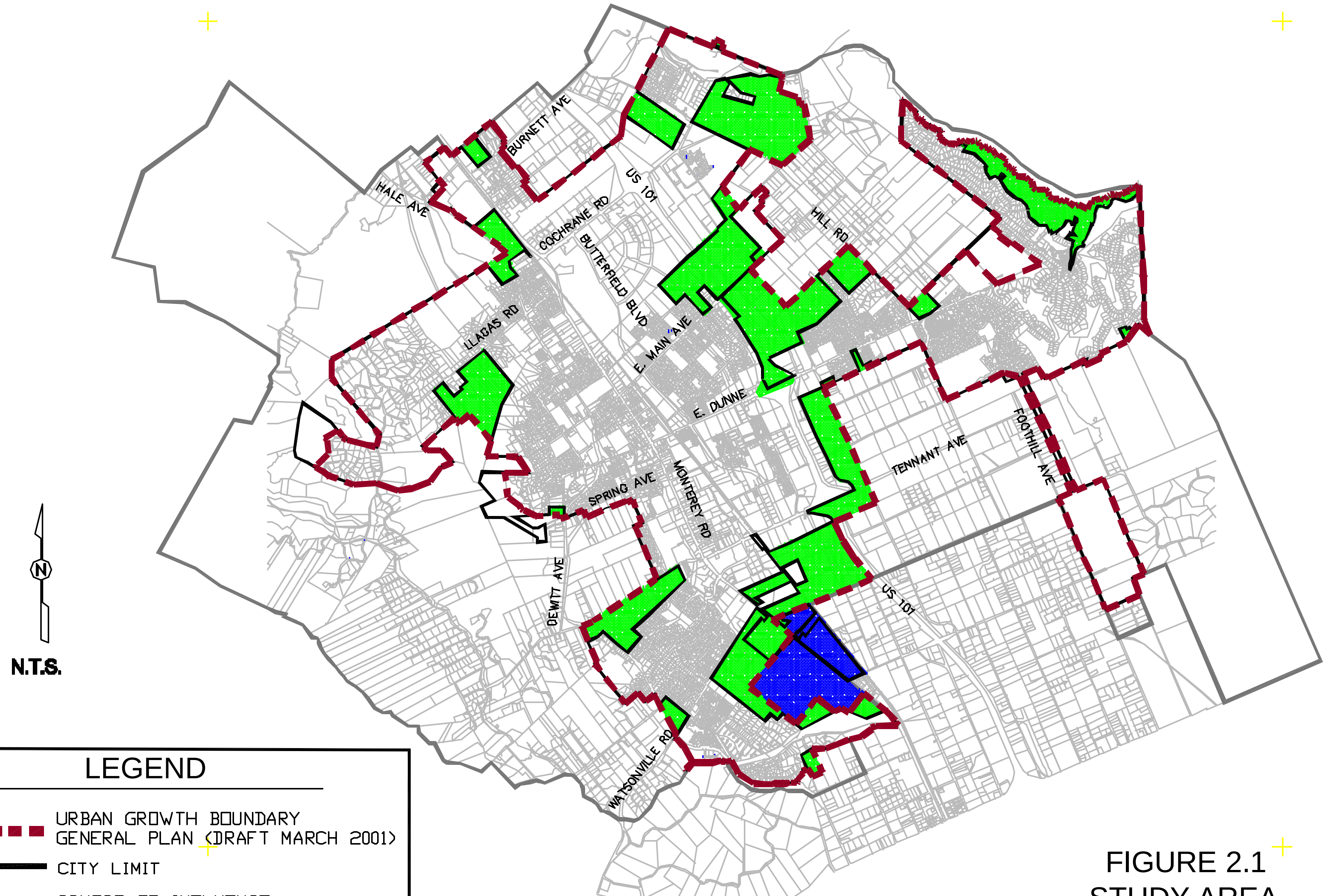
The 2001 General Plan Update developed by Crawford Multari & Clark Associates (Draft report dated March 2001), identifies the current boundaries of the UGB (Figure 2.1). The City's water distribution, sewer collection, and storm drainage master plans were prepared concurrently and identified the infrastructure necessary to service developed lands within the UGB. According to the General Plan, areas outside the UGB are intended to remain rural and unincorporated for the next 20 years.

2.2 SOIL AND TOPOGRAPHY

The study area forms in the southern Santa Clara Valley and encompasses the eastern foothill slopes of the Santa Cruz Mountain range and the western foothill slopes of the Mt. Hamilton range, and the broad, flat alluvial plain between them. The majority of the land within the study area is flat, alluvial terrain. The level terrain is adjoined by rolling foothills and steeper slopes of the mountain ranges, both to the east and west. The dominant soil types are upland soils developed on sedimentary, basic igneous, and serpentine rock, the slow to very slow draining subsoils of alluvial fans, and the moderately well to rapid draining medium to fine textured soils of the alluvial plain. Soil cover and vegetation in the area includes a wide range of trees, thick brush, and grass.

Most of the City is on relatively flat valley land, with some developments on the foothill areas both east and west of the valley floor. Elevations range from approximately 350 feet on the valley floor to over 1,200 feet in the foothills.

Geologically, the City of Morgan Hill is situated on the drainage divide between the San Francisco Bay and Monterey Bay. The majority of the valley floor slopes down southward and drains into the Pajaro River and Monterey Bay. A portion of the valley floor slopes down northward and drains into Fisher and Coyote Creek, thence to San Francisco Bay.



LEGEND

URBAN GROWTH BOUNDARY GENERAL PLAN (DRAFT MARCH 2001)

CITY LIMIT

SPHERE OF INFLUENCE

EXPANSION AREAS

AREA ADDED TO GENERAL PLAN (ADOPTED JULY 2001)

FIGURE 2.1
STUDY AREA

CITY OF MORGAN HILL
MASTER PLAN

H:\Client\MorganHill_FNO\6179A.00\10-Reports\Graphics\ES-11211

Flood control for the City’s creeks and control of the two local groundwater basins are under the jurisdiction of the Santa Clara Valley Water District (SCVWD). The majority of the City is located over the Llagas groundwater basin with the Coyote groundwater basin situated just to the north of the City. SCVWD also owns and operates several reservoirs within the watersheds tributary to the City.

2.3 LAND USE

The land use classifications used in this master plan are consistent with the Land Use Element of the City's General Plan Update, and as later updated on a map provided by Crawford Multari & Clark Associates, dated March 2001 (Figure 2.2). The land use designations are summarized in Table 2.1, along with residential densities, current vacant lands, and planned annexations within the next 20 years.

Residential Estate (RE). This designation is intended to promote family living on large parcels of land. Concentrated along the western and southern City limits, The maximum density of this land use designation is one dwelling unit per acre.

Single Family Low (SFL). This designation is intended to accommodate single family homes on medium-sized parcels. The highest concentrations of this category are the eastern City limits, especially near Anderson Reservoir. The maximum acceptable density for new developments is three dwelling units per acre.

Single Family Medium (SFM). This designation is dispersed throughout the City providing a transition from non-residential areas to lower density neighborhoods. The maximum acceptable density of this designation is five dwelling units per acre.

Multi-Family Low (MFL). This designation is intended to accommodate both attached and detached residential dwelling units with a maximum acceptable density of 15 dwelling units per acre.

Multi-Family Medium (MFM). This highest density residential designation consists mainly of attached apartments and condominiums, and allows a maximum of 21 dwelling units per acre.

Retail Commercial and Non-Retail Commercial (COM). The retail commercial designation is intended for retail business, office uses, and professional services. The Non-Retail Commercial promotes service and office spaces away from major intersections. It also accommodates mixed use developments (residences above shops). For the purpose of this master plan, these two designations are combined.

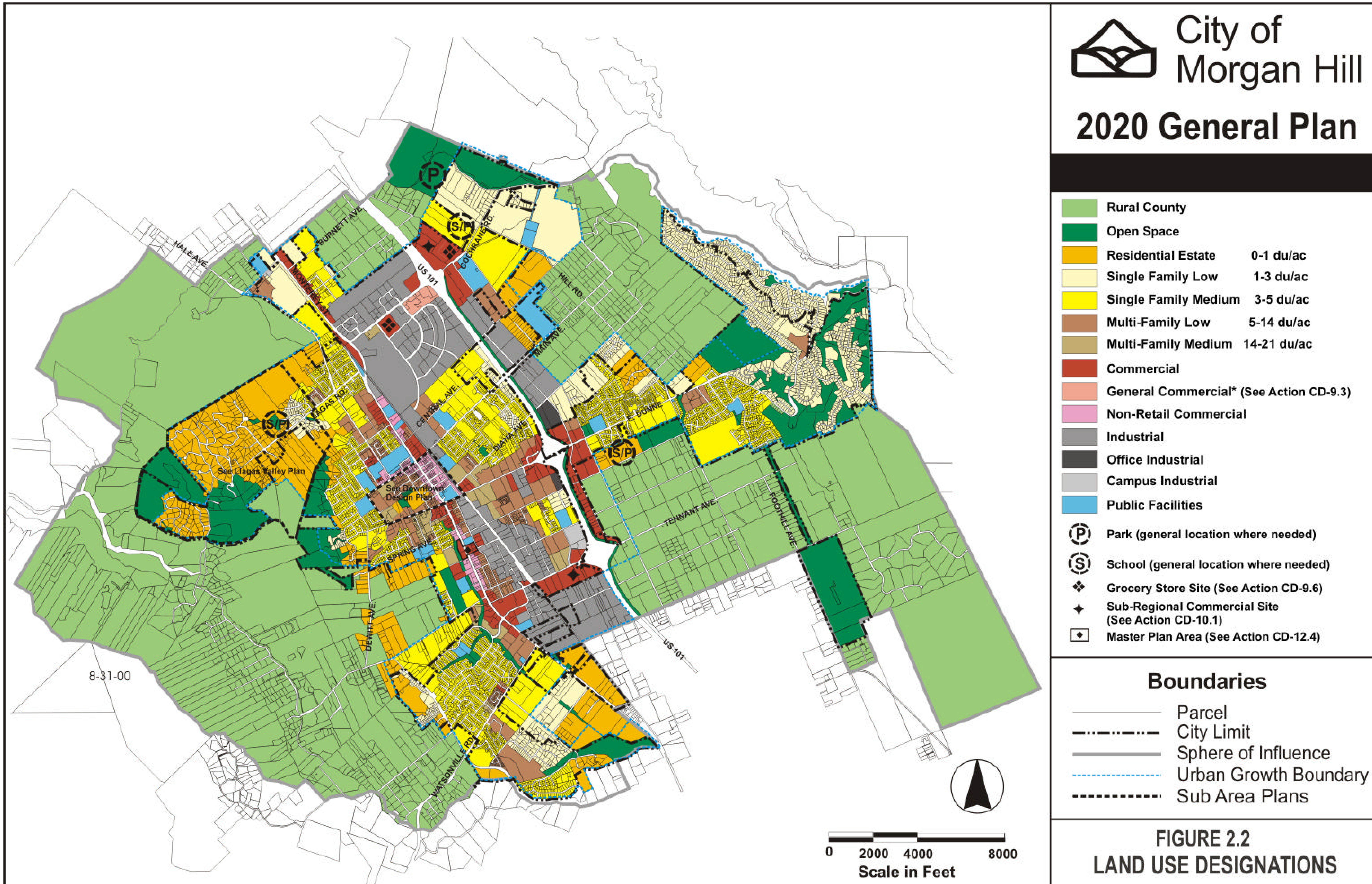
General Commercial (GCOM). This designation allows a variety of commercial uses.

Mixed Use (MIX). This designation is intended to encourage a mixture of retail uses and residences.

Table 2.1 - Land Use and Vacant Areas
Storm Drainage System Master Plan
City of Morgan Hill

Land Use Designations	Coded Desig.	Density Range (DU/gr. Ac.)	Existing Condition Within City Limits[1] 2001 Developed (net Ac.)[3]	2001 Vacant (net Ac.)[3]	2001 Total (net Ac.)[3]	Future Condition: Buildout Within Urban Growth Boundary 2001 Developed (net Ac.)[3]	2001 Vacant (net Ac.)[3]	UGB Total (net Ac.)[3]	Future Condition: Buildout Within Sphere of Influence[1,4] SOI Developed (net Ac.)[3]	SOI Vacant (net Ac.)[3]	SOI Total (net Ac.)[3]
Residential Land Uses											
Residential Estate	RE	< 1	513	356	869	609	474	1,083	751	465	1,216
Single Family Low	SFL	1 - 3	597	109	706	753	391	1,144	776	503	1,279
Single Family Medium	SFM	3 - 5	1,083	402	1,485	1,108	626	1,734	1,110	691	1,801
Multi-Family Low	MFL	5 - 14	302	160	462	314	179	493	310	221	531
Multi-Family Medium	MFM	14 - 21	98	69	167	94	68	162	98	73	171
Subtotal			2,593	1,096	3,689	2,878	1,738	4,616	3,045	1,953	4,998
Non-Residential Land Uses											
Commercial (retail)	COM		272	273	545	282	298	580	282	172	454
General Commercial	GCOM		23	1	24	22	1	23	23	1	24
Industrial	IND		382	318	700	388	337	725	392	720	1,112
Office Industrial	OIND		0	21	21	0	21	21	0	26	26
Campus Industrial	CIND		2	18	20	4	101	105	4	14	18
Mixed Use	MIX		42	3	45	42	3	45	42	8	50
Subtotal			721	634	1,355	738	761	1,499	743	941	1,684
Other Land Uses											
Open Space	OS		151	979	1,130	154	851	1,005	296	2,197	2,493
Public Facilites	PUB		45	172	217	47	191	238	50	203	253
Rural County (Outside SOI)	RC		6	76	82	119	329	448	2,680	5,383	8,063
Subtotal			202	1,227	1,429	320	1,371	1,691	3,026	7,783	10,809
Total			**3,516**	2,957	6,473	3,936	3,870	**7,806**	6,814	10,677	17,491

Notes:
1. Source: City of Morgan Hill General Plan Update: Crawford Multari & Clark Associates. March 2001.
2. All acreages were extracted from the Parcels database and exclude street ROW.
3. General Plan acreages were based on the Parcels database, and are therefore considered net acres.
4. The Rural County Designation Includes lands within the City's Sphere of Influence but which may be outside the urban growth boundary.



Source: City of Morgan Hill; Crawford Multari & Clark

Industrial (IND). This designation is intended for a variety of existing and potential research, warehouse, manufacturing, service commercial and other uses.

Office Industrial (OIND). This designation is intended to promote administrative and executive office uses.

Campus Industrial (CIND). This designation is intended to promote high technology and medical services in park-like setting that contain large areas of landscaping.

Public Facilities (PUB). This designation is comprised of lands used by the City, service providers (including emergency medical, hospitals and utility companies), and the Morgan Hill Unified School District.

Rural County (RC). This designation applies to over 8,000 acres outside the current City limits in the Sphere of Influence. Lots with Rural County designation generally are 5-20 acres with one single family home or agricultural operation. The maximum density of the Rural County designation is generally one dwelling unit per 5 acres.

Open Space (OS). Public parks and private golf courses account for most of the acreages of Open Space designation in the City and Sphere of Influence. Measure P dictates that land in the City that was designated Open Space as of 1990 shall remain so through year 2010.

2.4 HISTORICAL AND FUTURE GROWTH

The City was incorporated in 1906 and was primarily an agricultural settlement serving farms and ranches. As the City was transformed into a primarily suburban residential community in the 1960’s, two growth control measures passed in the 1980’s resulted in a reduced growth rate. From 1970 to 1980, population has increased from approximately 5,600 to 16,800, an average annual growth rate of 11.5 percent over the 10-year period. From 1980 to 2000, population has grown from 16,800 to 33,000, with an average annual growth rate of 3.5 percent over the 20-year period. During this period, the annual population growth has ranged between a low of 1.1 percent in 1983 to a high of 6.3 percent in 1989.

The Morgan Hill General Plan Update (Draft dated March 2001), assumes that the current residential growth control will remain through the planning horizon year of 2020, yielding an average annual growth rate over the next 20 years of 1.8 percent (Table 2.2). The General Plan Update further projects population ceilings of 38,800 and 48,000 for the years 2010 and 2020, respectively. Year 2020 also coincides with the planning horizon for these master plans.

The General Plan Update stipulates consistency with the California Department of Finance (DOF) for determining occupancy levels per dwelling units. The DOF indicates that housing information from the 2000 Census will be available in the early part of 2002, and that as of

January 1, 1999, the household size in the City of Morgan Hill was 3.19 (people per dwelling units). For master planning purposes, a household size of 3.2 will be used.

Table 2.2 Historical and Projected Population
Water System Master Plan
City of Morgan Hill

Year	Population[1,2,3]	Annual Growth (%)	Historical and Projected Growth		
1980	16,800				
1981	17,600	4.8%			
1982	18,050	2.6%			
1983	18,250	1.1%		1980-1990	
1984	18,550	1.6%		10-year	
1985	19,200	3.5%		Average	
1986	19,950	3.9%		3.6%	
1987	20,500	2.8%			
1988	21,400	4.4%			Historical
1989	22,750	6.3%			20-year
1990	23,950	5.3%			Average
1991	24,800	3.5%			3.5%
1992	25,100	1.2%			
1993	25,650	2.2%		1990-2000	
1994	26,200	2.1%		10-year	
1995	26,900	2.7%	1995-2000	Average	
1996	28,100	4.5%	5-year	3.3%	
1997	29,250	4.1%	Average		
1998	30,700	5.0%	4.2%		
1999	31,900	3.9%			
2000	**33,092**	3.7%			
2001	33,700	2.0%	5-year		
2002	34,400	2.0%	Average		
2003	35,100	2.0%	2.0%		
2004	35,800	2.0%			
2005	**36,500**	2.0%			
2006	36,900	1.2%	5-year		2001
2007	37,300	1.2%	Average		General
2008	37,800	1.2%	1.2%		Plan
2009	38,300	1.2%			Update
2010	**38,800**	1.2%			20-year
2011	39,700	2.3%	5-year		Average
2012	40,600	2.3%	Average		1.87%
2013	41,500	2.3%	2.3%		
2014	42,400	2.3%			
2015	**43,400**	2.3%			
2016	44,300	2.1%	5-year		
2017	45,200	2.1%	Average		
2018	46,100	2.1%	2.1%		
2019	47,000	2.1%			
2020	**48,000**	2.1%			

Notes:
1. Historical Population Source: California Department of Finance.
2. US Census Bureau lists Historical Population for Morgan Hill of 17,060 in 1980 population, 23,928 in 1990, and 33,556 in 2000
3. Population Projections Source: City of Morgan Hill General Plan Update (Draft March 2001, and Adopted July 2001) prepared by Crawford Multari & Clark Associates.

PLANNING AND DESIGN CRITERIA

The City's storm drainage facilities were evaluated based on the analysis and design criteria defined in this chapter. Precipitation characteristics, design storm duration and frequency, and impervious vs. pervious surfaces were reviewed to perform the hydrologic analysis on the system. The developed criteria address the storm drainage system capacity, the performance of the detention ponds, and main channel capacities.

3.1 HYDROLOGIC ANALYSIS

Santa Clara Valley Water District (SCVWD), responsible for the major flood control system within the County of Santa Clara, has developed a Hydrology Procedures Manual, dated December 1998. The manual provided design flood parameters and procedures in the planning and design of local drainage and flood control systems. The hydrologic analysis of the City's storm drainage system was based on the recommendations of this Hydrology Manual, as applicable to local drainage issues.

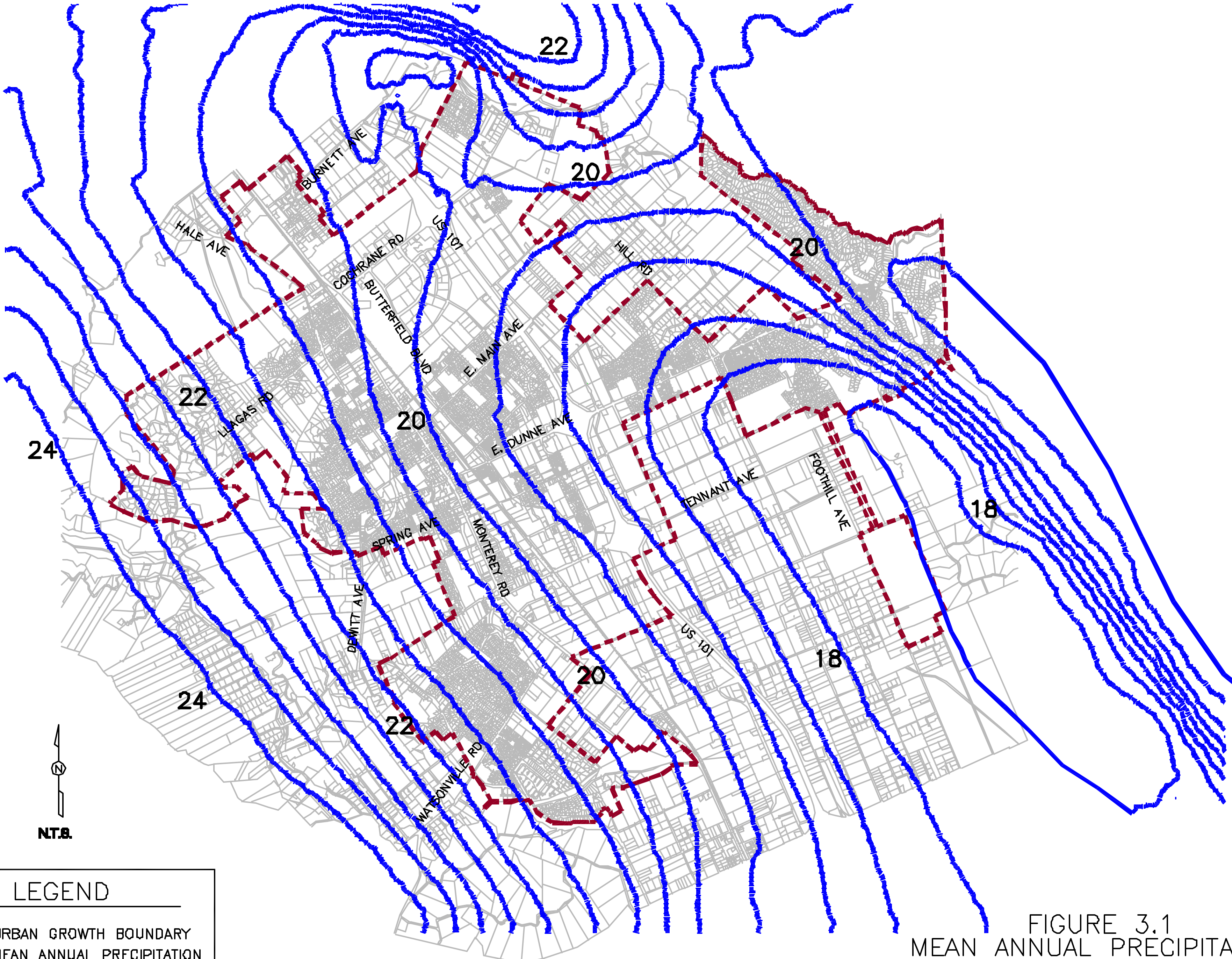
3.1.1 Precipitation Characteristics

The Morgan Hill wet season occurs from late October through early April, although the largest historical storm events occurred in the December-February period. Typically, precipitation amounts from storms originating in the Pacific Ocean reach their maximum at the higher elevations of the coastal ranges and decrease with the lower elevations of the inland valleys. Figure 3.1 shows that mean annual precipitation was greatest on the hills west of the City (maximum 24 inches) and reached a minimum (17.5 inches) on the valley floor at the southeast part of the City.

3.1.2 Elements of a Design Storm

The planning and design of storm drainage facilities required the selection of a level of protection provided by those facilities. The level of protection is often expressed in terms of the frequency, or return period, of the storm for which the facilities are to prevent damage or for which the facilities will safely pass the stormwater flows. This storm is referred to as the design storm and is an idealized representation of a typical storm with a specified return period.

Selection of the design storm can have a significant impact on the size and cost of required drainage facilities. There are three elements of a design storm: precipitation depth, duration, and frequency.



LEGEND

URBAN GROWTH BOUNDARY
MEAN ANNUAL PRECIPITATION 1/2 INCH INTERVALS
24 PRECIPITATION IN INCHES

FIGURE 3.1
MEAN ANNUAL PRECIPITATION
CITY OF MORGAN HILL
STORM DRAINAGE SYSTEM MASTER PLAN

H:\Client\MorganHill_FNO\6179A.00\10-Reports\StormDrainMasterPlan\FIG3-1

3.1.2.1 Precipitation depth

This element is the amount of precipitation occurring during a specified storm duration. The depths of rainfall are statistical depths obtained by studying historical precipitation data to find the depth, for each duration, for a particular frequency. Precipitation depth is usually expressed in inches.

3.1.2.2 Duration

This element is the specified length of storm time considered. Duration of a design storm event should be at least four times the response time of the basin. The response time is the time required for the flow peak to reach the point of interest, such as a structure, outlet or spillway. Duration may be expressed in any time unit such as minutes, hours, or days.

3.1.2.3 Frequency

This element is the frequency of occurrence of events with the specified precipitation depth and duration. It is expressed in terms of the return period. In order to provide a reasonable level of flood protection, the statistical concept of return period or recurrence interval is utilized which aids in assigning a probabilistic meaning to a precipitation event.

3.1.3 Morgan Hill's Design Storm

Two design storms were used for the evaluation of Morgan Hill's existing drainage system, and for the design of future drainage facilities. The 10-year event was used for evaluating conveyance facilities while the 100-year event was used for evaluating the existing ponds. The 10- and 100-year recurrence intervals have become standard selections in most locations in California because they provide a balance between level of service and affordability and provide reasonable standards of care that is most defensible in court.

3.1.3.1 Conveyance Facilities

The 24-hour, 10-year design storm was used for sizing of conveyance facilities for drainable areas. This storm was consistent with the current City of Morgan Hill design standards. The 24-hour, 100-year design storm was used to determine if street flooding exceeds one foot in depth and could flood buildings or create serious safety hazards.

3.1.3.2 Detention and Retention Basins

The City's existing design standards stipulate that areas larger than one acre shall tie on-site drainage into the City's storm drainage system. Ponding basins on private or public property shall be designed for a 24-hour, 25-year storm event if a reasonable outlet is provided (detention). If no disposal other than evaporation, percolation irrigation is provided (retention), a 24-hour, 100-year storm shall be used.

For analysis purposes, this master plan used the 24-hour 100-year design storm for evaluating both retention and detention basins. This storm is consistent with the SCVWD Hydrology Procedures manual. The 100-year design flood, as used by FEMA, provided the boundary conditions for main channel receiving systems.

3.3.2.3 Rainfall Frequency

After evaluating a long historical record of maximum rainfall intensities for varying durations, a reasonable statistical interpretation can be made of the data to determine estimates of rainfall intensities or depths as a function of storm duration and of return frequency. Design storms for Morgan Hill were based on Depth-Duration-Frequency (DDF) statistics derived from precipitation records for Santa Clara County, as shown in Table 3.1. The design storms provided one consistent station for Morgan Hill, and was adjusted for the mean annual precipitation in each subbasin.

3.1.4 Soil Imperviousness

For stormwater modeling, the key factor relating land use to runoff is “effective percent imperviousness”. Rainfall on impervious surfaces is not subject to losses by infiltration into the soil, the only losses in impervious areas are due to depression storage. All initial losses for impervious areas, typically 0.02 to 0.08 inches, are assumed to be satisfied by precipitation preceding the design storm.

3.1.4.1 Effective Percent Imperviousness

The basin proportion of effective, or connected, impervious area is related to land use, stormwater drainage system configuration, and recurrence interval. If runoff from an impervious area flows directly into a concentrated flow path such as into a gutter, it is considered connected. If it flows over a pervious area before becoming concentrated flow, it is unconnected.

The existing impervious cover in small urban areas can be estimated by direct measurements of land use from aerial photography. The impervious area for future land use must be determined from maps contained in the general plan. In order to make that determination, it is necessary to develop a table of effective percent impervious values for each land use code. Table 3.2 lists the suggested values for effective percent of impervious area based on the Morgan Hill land use designations.

3.1.4.2 Non-Effective Percent Perviousness

In residential urban areas, a portion of the pervious runoff area either has no flow path to the drainage system, or the flow path is via groundwater drains which effectively delays runoff until it does not contribute to the design hydrographs. These areas are typically backyards, swimming pools, dense shrub landscaping, and gardens. Table 3.2 also lists values for non-effective percent pervious.

Table 3.1 Precipitation Depth-Duration-Frequency
Storm Drainage Master Plan
City of Morgan Hill

Duration	2-yr		5-yr		10-yr		25-yr		100-yr	
	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)
5-min	0.12	1.47	0.15	1.83	0.18	2.10	0.21	2.49	0.26	3.09
10-min	0.18	1.09	0.23	1.36	0.26	1.56	0.31	1.85	0.38	2.30
15-min	0.23	0.92	0.29	1.14	0.33	1.31	0.39	1.55	0.48	1.93
30-min	0.34	0.68	0.42	0.85	0.49	0.97	0.58	1.15	0.72	1.43
1-hr	0.51	0.51	0.63	0.63	0.72	0.72	0.86	0.86	1.06	1.06
2-hr	0.75	0.38	0.93	0.47	1.07	0.54	1.27	0.64	1.58	0.79
3-hr	0.95	0.32	1.18	0.39	1.35	0.45	1.60	0.53	1.99	0.66
6-hr	1.40	0.23	1.75	0.29	2.01	0.33	2.38	0.40	2.95	0.49
12-hr	2.08	0.17	2.59	0.22	2.98	0.25	3.53	0.29	4.38	0.37
24-hr	3.09	0.13	3.85	0.16	4.42	0.18	5.24	0.22	6.50	0.27

3.1.4.3 Pervious Area Runoff

The remaining runoff originates from pervious areas. The SCS (Soil Conservation Service, presently National Resource Conservation Service) Curve Number procedure was used to determine pervious runoff. Curve numbers for various hydrologic soil types are shown in Table 3.2.

3.2 WATERSHED MODELING

Hydrologic analysis of the Morgan Hill system was performed using a mathematical watershed model (HEC-1) developed by the Corps of Engineers, Hydraulic Engineering Center, Davis, California. HEC-1 was designed to simulate the surface water runoff response of a drainage basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. The result of the modeling process was a tabulation of stream flow hydrographs at desired locations within the basin.

3.2.1 Design Hyetographs

Design hydrographs were determined using HEC-1, which is incorporated in the Morgan Hill HEC-1 windows based processor. The 10-yr and 100-yr 24-hour storms with 5-minute time steps were used in this analysis. The hyetographs were balanced so that 5-, 10-, 15-, etc intensities were nested symmetrically within the 24-hr storm. They were constructed (by the HEC-1 processor) from DDF data shown in Table 3.1. The design storms were corrected by the ratio of mean annual precipitation at the subbasin to mean annual precipitation at the gage.

A summary of the hydrologic methodology is provided below:

- Land use derived impervious percent and SCS Curve Number for precipitation excess, and kinematic wave routing with separate impervious and pervious flow paths.
- Muskingum-Cunge (HEC-1 manual) routing for ditches, channels and streams.
- For residential areas, adjustments (in the HEC-1 processor) for urban landscaping and non-effective runoff areas in backyards.

3.2.2 Lag Time

The lag time of a subbasin was calculated by the travel time component method. The travel time component method has been shown in many studies to be the most accurate. The flow path was defined as the most likely flow path between the most upstream part of the subbasin and the downstream point of interest.

Table 3.2 Effective Percent Imperviousness and SCS Curve Numbers
Storm Drainage Master Plan
City of Morgan Hill

Land Use Category	Land Use Code	Residential Density (DU/ga)	Percent Impervious	AMC-II Pervious Soil B	AMC-II Pervious Soil C	AMC-II Pervious Soil D
Residential Estate	RE	< 1	10	64	74	82
Single Family Low	SFL	1 - 3	20	65	75	82
Single Family Medium	SFM	3 - 5	35	67	77	83
Multi-Family Low	MFL	5 - 14	50	70	79	83
Multi-Family Medium	MFM	14 - 21	80	79	86	88
Commercial	COM, GCOM, OIND, GIND, MIX		95	80	87	89
Industrial	IND		70	76	84	86
Open Space	OS		1	63	75	81
Public Facilites	PUB	Schools	50	70	79	83
Rural County	RC		5	63	73	82
Other Uses						
Water Surface			99	99	99	99
Natural Grassland			1	63	75	81
Oak Woodland			1	65	77	82
Chaparral/Shrubs/Weeds			1	62	74	80
Orchards, Vineyards			2	86	91	93
Pasture, Golf Courses, Parks			2	69	79	84
Agricultural Crops			2	78	85	89
Pavement/Parking/Highways			98	99	99	99
Urban Landscaping			1	56	69	75
Urban Lawns (fair quality)			1	65	77	82
Urban Lawns (poor quality)			1	74	83	87

To determine the composite lag time, the various components of overland flow, gutter flow, pipe flow, and channel flow were specified to determine a total time of travel as shown below:

$$\text{Lag Time} = T_o + T_g + T_p + T_c$$

where:

T_o= Overland flow time
T_g= Gutter flow travel time
T_p= Pipe flow travel time
T_c= Channel flow travel time

3.2.2.1 Overland Flow

Popular methods for determining overland flow velocity include the SCS velocity nomograph/equation and the kinematic wave equation. The kinematic ware was selected for this study. Table 3.3 lists parameters for overland flow using the kinematic wave equation.

Table 3.3 Parameters for Overland Flow
Storm Drainage Master Plan
City of Morgan Hill

Surface	Overland Manning's n	Distance/ Range (ft)
Pavement – smooth	0.02	50-200
Pavement – rough/cracked	0.05	50-200
Bare soil - newly graded areas	0.10	100-300
Range - heavily grazed	0.15	100-300
Turf - 1-2"/lawns/golf courses	0.20	100-300
Turf – 2-4"/parks/medians/pasture	0.30	200-500
Turf – 4-6"/natural grassland	0.40	200-500
Residential Landscaping	0.30 - 0.60	100-300
Few trees – natural grass undergrowth	0.50	300-600
Scattered trees – weed/shrub undergrowth	0.60	300-600
Numerous trees – dense undergrowth	0.80	300-600

Note: Flow Depths less than 2 inches

3.2.2.2 Gutter Flow

A triangular street cross section was used to determine flow velocity and travel times for street gutter flow. Required inputs were gutter slope, street cross slope and Manning's "n" coefficient. A typical contributing area, representative of the beginning of street flow, was used by the program to determine flow depths in the gutters.

3.2.2.3 Pipe Flow

Manning's equation for pipe flow was used to determine travel time for flow through pipes. The program calculated pipe travel time using entered values for slope, diameter and Manning's n. A typical contributing area representative of the first upstream street inlets was used by the program to determine flow depths.

3.2.2.4 Channel Flow

Manning's equation for open channel flow was used to derive travel time, velocity, flow and width relationships for channels. The program calculated ditch or channel travel time using entered values of slope, width, bank side slope and Manning's n. The program required input of a typical contributing area to determine depth of flow.

3.2.3 Relevant Assumptions

Other relevant assumptions related to the hydrologic modeling of the City's drainage system include:

- FEMA 100-yr water surface elevations will be used as the downstream control for all facilities where FEMA flood profiles are available. FEMA detailed maps are available for Llagas Creek, Madrone Channel (to Cochrane Road), and Coyote Creek. The FEMA maps for West Little Llagas Creek were not representative of 2020 channel improvements and were not used as boundary controls. This greatly decreases backwater elevations on the local drainage system.

- Butterfield Channel will be completed along future Butterfield Blvd and continue south along the SPRR until entering a temporary retention basin (ultimate detention basin) near Middle Avenue.

- Tennant Creek channel will be improved from Diane Avenue south to Corralitos Creek which is south of Maple Avenue. Improvements south of there will be provided by SCVWD.

- The West Little Llagas Creek bypass channel at Watsonville Road will be completed south to Llagas Creek. The remainder of Little Llagas Creek channel will be completed upstream of Llagas Road.

3.3 HYDRAULIC CRITERIA

A computer hydraulic model, PCSWMM, was used to analyze and identify deficiencies in the existing storm drainage system and to propose system improvements. Existing storm drainage pipes greater than 21 inches with significant tributary areas will be included in the hydraulic models. Deficiencies and solutions will be identified for existing and future land use conditions.

3.3.1 Conveyance Facilities

Conveyance facilities in Morgan Hill consist mainly of storm drainage pipes with some open channels. The flow capacity of a reinforced concrete storm drainpipe was based on the hydraulic model (PCSWMM) or on Manning's equation with the pipe flowing full. Manning's 'n' value or friction factor for pipeline design will be assumed at 0.015. Storm drainpipes were designed for the appropriate design storm, using the previously established level of protection criteria based on the total tributary area to the storm drainpipe.

When evaluating the adequacy of the existing conveyance facilities serving existing developments, City streets were allowed to flood and provide an additional storage capacity, thus mitigating cost-prohibitive improvements. The storm drainage criteria provided in this master plan will reduce the allowable floodwater accumulation in streets to 1 foot above the gutter flowline, at the lowest elevation in the modeled system.

3.3.2 Detention Basins

Stormwater detention basins were designed and incorporated into the drainage system to reduce the peak rate of discharge, and to reduce the capital cost of the total drainage system. Detention facilities operate by storing excess flow during the most intense portion of the storm, and then releasing this flow as conveyance capacity in the drainage system becomes available.

Required capacities (volumes) of detention basins were computed using the hydrologic computer model (HEC-1), with the 100-year storm at buildout land use conditions of the City’s General Plan.

3.3.3 Pumps

In Morgan Hill, storm drainage pumps are utilized either for emptying storm water from detention basins to conveyance facilities (pipes, ditches), or for pumping storm water from sumps (i.e. Monterey Road railroad crossing).

Detention Basin Pumps. When evaluating the capacities of detention basin pumps, sizing requirements were determined based on the capacity of the storm water system available for discharge.

Direct Discharging to Ditches. When evaluating the capacities of pumps discharging storm water directly into ditches, sizing requirements were determined based on flows reaching the pumps. It should be noted that flows reaching the pumps vary depending on the upstream conditions allowed.

EXISTING SYSTEM AND HYDRAULIC MODEL

This chapter presents an overview of the City's storm drainage facilities. The chapter also describes the development of the City's Storm Drainage Hydrologic and Hydraulic Models. These models were used for identifying existing system deficiencies and for recommending enhancements.

4.1 SYSTEM OVERVIEW

The City of Morgan Hill's storm drainage system consists of a combination of curb and gutter facilities, curb inlets, underground pipelines, and bubblers draining to the nearest creek or to manmade natural retention areas. It has been reported that the storm drainage improvements constructed before 1982 were designed without the benefit of a City wide master plan, and therefore connected to the nearest creek with no known consideration of the downstream impact.

Over the past decade, City staff have assertively required developers to construct storm drainage facilities (pipelines, ponds, pump station), as part of their proposed developments, and in compliance with the 1988 Plan. Additionally, since the adoption of the 1982 Subdivision Design Standards, new subdivisions have been required to construct interim site retention or detention ponds to limit the amount of storm runoff to the pre-development peak rates.

4.2 DRAINAGE BASINS

The City of Morgan Hill is divided into several hydrologically distinct drainage areas, as shown on Figure 4.1. Each drainage area has a system of conveyance facilities, pumps, and detention basins to collect and dispose the runoff. The storm water runoff from these areas is collected and ultimately discharged into creeks that flow through the City and are tributary to either of the Monterey Bay or San Francisco Bay.

The drainage areas include Coyote Creek, Fisher Creek, Tennat Creek, Madrone Channel, Butterfield Channel, West Little Llagas Creek, and Llagas Creek. Each drainage area has a system of conveyance facilities, pumps, and basins to collect and dispose the runoff.

4.2.1 San Francisco Bay Tributary

Fisher Creek Basin and Coyote Creek Basin drain the northern portion of the City and continue in a northerly direction to the San Francisco Bay.

Fisher Creek generally drains the area north of Llagas Road and Cochrane Road, and west of US Freeway 101. Coyote Creek drains the are north of Cochrane Road and east of US 101 Freeway.

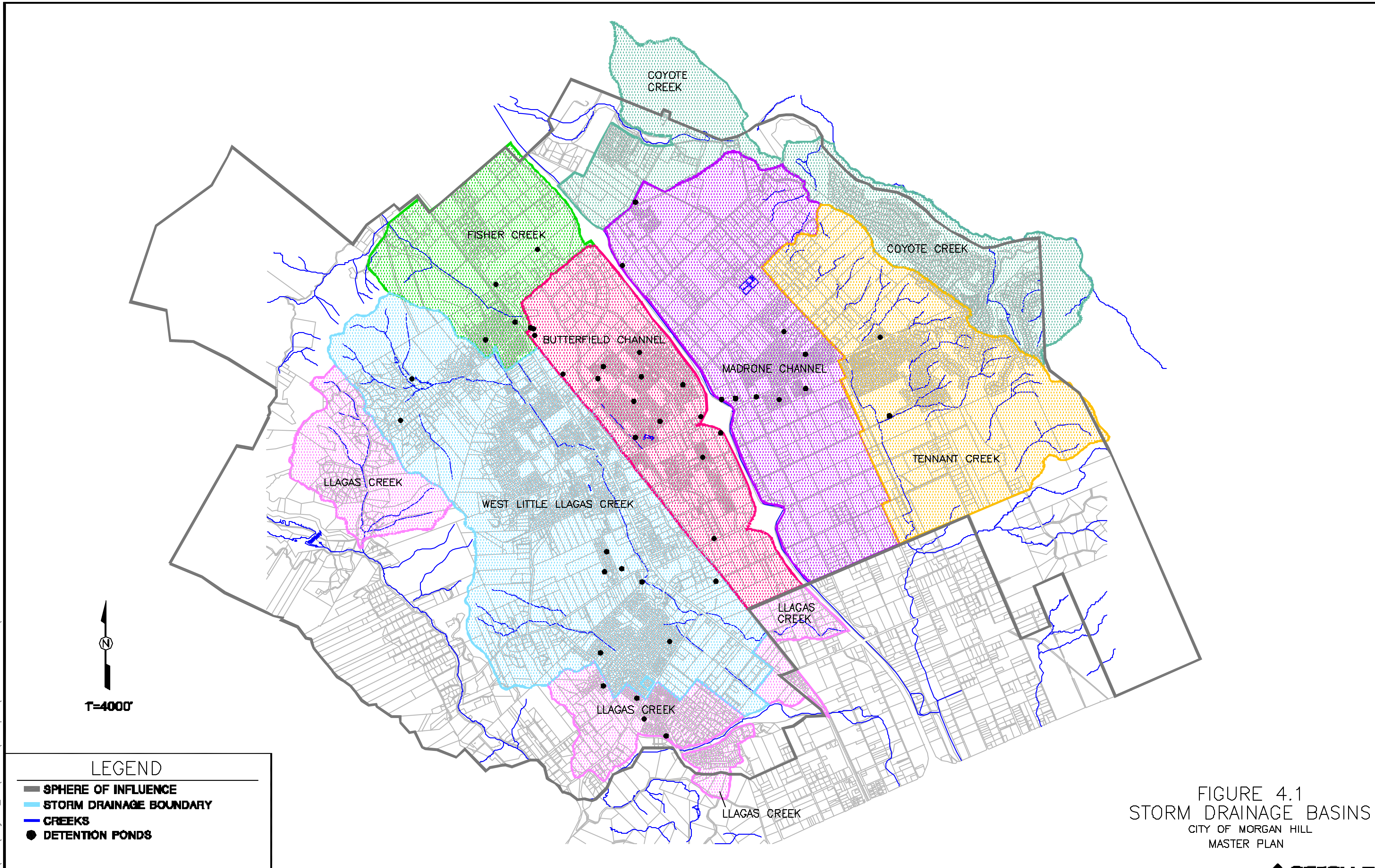


FIGURE 4.1
STORM DRAINAGE BASINS
CITY OF MORGAN HILL
MASTER PLAN

carollo engineers

4.2.2 Monterey Bay Tributary

West Little Llagas Creek, Butterfield Channel, Madrone Channel, Tennant Creek, and Llagas Creek drain the majority of the City and merge with Llagas Creek which continues to Monterey Bay.

4.2.2.1 West Little Llagas Creek and Llagas Creek Watershed PL-566 Program

The U.S. Department of Agriculture, Soil Conservation Service has initiated a watershed protection and flood prevention project that includes portions of the Cities of Gilroy and Morgan Hill. In Morgan Hill, the project extends upstream along West Little Llagas Creek.

The project, designed to reduce flooding in agricultural and urban areas in Southern Santa Clara County, is sponsored by the Loma Prieta Resource Conservation District, the Gavilan Water Conservation District, and the Santa Clara Valley Water District. The project is known as PL-566 and consists of approximately 16.6 miles of improved channel with increased capacity and enhanced alignments. The project is being constructed in stages beginning at the Pajaro River and moving upstream toward Morgan Hill. Project specific details can be found in an Environmental Impact Statement/Report dated December 1981.

Although PL-566 improvements have not begun in Morgan Hill, several stream improvements have been made in accordance with the Llagas Creek Watershed program. The improved sections include a portion south of East Dunne Avenue and one in the vicinity of Vineyard and Edmundson Avenue.

4.2.2.2 Butterfield Channel

Butterfield Channel, previously named Sutter Channel, is an improved channel that drains the area west of US Freeway 101 and east of Railroad Avenue to East Little Llagas Creek. The project will consist of an open drainage channel along the eastern side of Butterfield Boulevard extension and a 27.6 acre detention pond on the south side of Maple Avenue. The drainage channel will begin south of Jarvis Drive on the north, and extend to Maple Avenue on the south. The channel is presently complete from Jarvis Drive to San Pedro Avenue and serves as an interim detention basin pending completion of the remainder of the channel and the 27-acre detention basin.

It should be noted that future improvements to East Little Llagas Creek channel will be required to increase the conveyance capacity downstream of the detention pond. Alternately, the detention pond will need to be designed so that outflow does not exceed the existing conveyance capacity of the creek. Project specific details can be found in an Environmental Impact Report dated October 1992.

4.2.2.3 Madrone Channel

Madrone Channel is an improved channel constructed as a part of the U.S. 101 Freeway and intended to provide drainage of the freeway and interception protection from the east foothill runoffs. The Madrone Channel is tributary to East Little Llagas Creek.

4.2.2.4 Tennant Creek

Tennant Creek, which drains south, is natural and unimproved.

4.2.2.5 Detention and Retention Ponds

To mitigate the impact of storm water flooding caused by urbanization of vacant lands within the City, Engineering and Public Works staff have required developers to construct new interim retention or detention ponds when construction new subdivisions. Table 4.1 provides a list of the existing detention ponds within each hydrologic basin.

4.3 HYDROLOGIC AND HYRAULIC MODELS

Many computer models are available to simulate hydrologic and hydraulic conditions in the City's storm drainage system. The existing system was evaluated using two separate computer models that analyzed the hydrology and hydraulics. Hydrologic analysis of the Morgan Hill drainage system was performed using the mathematical watershed model USCOE HEC-1 (U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package, 1991) and the hydraulic model EPA SWMM-Extran (Environmental Protection Agency, Stormwater Management Model, Extended Transport Module).

4.3.1 Hydrology

HEC-1 is a mathematical watershed computer model designed to simulate the surface water runoff response of a drainage basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. Each model component represents a specific aspect of the rainfall-runoff processes occurring in a portion of the watershed. A component may represent the runoff occurring in a subbasin, the routing of flows down a stream channel, or the routing of flows through a detention basin. The model operates by reading an input data file that contains the parameters describing each component of the drainage basin, along with information describing how the various components work together to form the drainage basin. The result of the modeling process was a tabulation of stream flow hydrographs at desired locations within the study area.

4.3.1.1 Model Components

Description of a model component requires the estimation of a set of parameters describing the hydrologic and hydraulic characteristics of the component. Parameters describing the various components of the model are based on land use, soils, vegetation, stream channels, and topography. For example, the land use in a subbasin will determine the

Table 4.1 Existing Detention Ponds
Storm Drainage Master Plan
City of Morgan Hill

Pond No.	Hydrology Basin	Description
1	Butterfield Channel	CAL4 Calle Central
2	Butterfield Channel	CEN9 El Toro School District
3	Butterfield Channel	BEN14 Walnut Creek Tract 8234 Private
4	Butterfield Channel	CAL24 Bells Estate Tract 8485 City Easement
5	Butterfield Channel	DIA21 Diana Estates Tract 8359 Private
6	Butterfield Channel	STJ3 St. Joseph Drive
7	Butterfield Channel	MON24 Woodcrest Estates
8	Butterfield Channel	DIA 29 Creekside Circle
9	Butterfield Channel	LAU5 Lyon's Private 58260
10	Butterfield Channel	WAL6 DBO Private
11	Butterfield Channel	RIT3 Cottage Green Private 3, 26982
12	Butterfield Channel	TEN8 Tennant Ave. Private
16	Fisher Creek / Butterfield	BUT26 Morgan Hill BP Combined- Pump Station
17	Fisher Creek	COC16 Sutter Business Park Private
18	Fisher Creek	WOO3 Cochrane Business Park Private
19	Fisher Creek	OLD3 Berkshire Chase 13,110 City
20	Fisher Creek	HAL2 Fox Hollow Tract 8108 City
21	Llagas Creek	STO3 Stone Gate
22	Llagas Creek	SKI1 Oak Creek
23	Llagas Creek	EXC2, Buena Vista Terrace
24	West Little Llagas Creek	TER1 Llagas Hills Estates Tract 8135
25	West Little Llagas Creek	CAS22 Castle Hill Tract 7678
26	West Little Llagas Creek	DAN2 Denali
27	West Little Llagas Creek	SUN61 Sunset Avenue
28	West Little Llagas Creek	OLY13 Community Park
29	West Little Llagas Creek	PIA3 Piazza Way
30	West Little Llagas Creek	VIA55 Via Castina
31	West Little Llagas Creek	CON28 Concord Circle- Pump Station
32	West Little Llagas Creek	VIA4 Hamilton Square Tract 8491 City
33	West Little Llagas Creek	LAA Mill Creek
34	Madrone Channel	COC2 Cochrane Road
35	Madrone Channel	STL9 St. Loise Health Center Private
36	Madrone Channel	CON3 Diambrosio Tract 8444 City
37	Madrone Channel	PEA3 Pear Drive
38	Madrone Channel	EDU8.8 Nordstrom Park
39	Madrone Channel	CON10 East Dunne Ave. 2
40	Madrone Channel	HOL1 Holiday Inn Pond
41	Madrone Channel	PIN1 Pinecone Court
42	Madrone Channel	PEP10 Vintage Park Tract 8264
43	Tennant Creek	EDU20 East Dunne Ave.
44	Tennant Creek	BAR4 Oak Glen Tract 8481

Notes:
1. Butterfield Pond number 16 is on a drainage divide. It is pumped to Fisher Creek and also overflows to the Butterfiled Channel when near capacity.

percent of that subbasin that is impervious and the average condition of the drainage channels, based on generalized percent impervious and channel condition values. These values, along with others describing additional components of the subbasin are placed in a computer input data file that is read by the HEC-1 computer model and used as a basis for computation of the rainfall/runoff processes in the subbasin.

4.3.1.2 Runoff Hydrographs

HEC-1 mathematically creates a runoff hydrograph (time-series of runoff values) for each subbasin based on the input parameters for the subbasin and the specified precipitation. Subbasin runoff hydrographs are combined where appropriate and are routed downstream using stream channel characteristics also described in the HEC-1 input data file. This process of runoff computation, combination, and routing continues from the upstream end of the watershed to the downstream.

4.3.1.3 HEC-1 Analysis

Existing land use for each drainage subbasin was determined using the aerial photography maps created as part of this project. Future land use was extracted from the zoning and land use elements of the City's General Plan.

HEC-1 used the kinematic wave procedure internally to calculate subbasin lag times. Separate HEC-1 processor files were established for each of the following principal basins: Butterfield, Coyote, Fisher, Llagas, West Little Llagas, Madrone and Tennant. Each hydrologic model, summarized in Appendix A, was used to simulate the following conditions:

- Existing land use conditions: 10-year, 24-hour storm
- Existing land use conditions: 100-year, 24-hour storm
- Buildout of General Plan land use conditions: 10-year, 24-hour storm
- Buildout of General Plan land use conditions: 100-year, 24-hour storm

Facilitating and standardizing the creation of the HEC-1 input file was accomplished with the development of a preprocessor computer program (HPRE). The main function of HPRE is to provide a consistent methodology for developing HEC-1 input data files describing the City's drainage areas. HPRE calculates the unit hydrograph for each subbasin based on the input hydrologic parameters. It also calculates the design storm precipitation based on the return period, storm duration, and area being modeled.

4.3.2 Hydraulics

The model used to simulate the hydraulic conditions in the City's storm drainage system is the Environmental Protection Agency (EPA), Stormwater Management Model (SWMM), and Extended Transport Module (EXTRAN). SWMM was originally developed for the City of San Francisco in 1973, and was later acquired by the Environmental Protection Agency

(EPA) who currently releases updates. EXTRAN was thus used to identify system deficiencies, and to recommend improvements to the modeled system. After each storm event simulation, system deficiencies were noted and fixed before proceeding to the next simulation.

The computer hydraulic model, EXTRAN, was used to analyze the storm drainage system, to identify deficiencies, and to propose system improvements. EXTRAN is a dynamic hydraulic routing model, used primarily for closed conduit systems, with the ability to combine closed and open channel systems. For Morgan Hill, runoff hydrographs were developed using HEC-1 and specified as input at appropriate locations in the EXTRAN models. These hydrographs were routed dynamically, through the system of conduits, to a specified outfall location. Backwater conditions that may occur as a result of submerged outfalls were taken into account in the routing. Output from the EXTRAN models included data on conduit design capacity, flow in the conduits, surcharge of junctions (manholes), and flooding if it occurred at junctions.

The EXTRAN models included existing storm drainage pipes 24-inches in diameter or greater, with models limited to those areas where system complexities or surcharge effects significantly influenced evaluation of pipe capacities. Simple pipe systems with diameters less than 24 inches and systems with relatively steep gradients were evaluated using the Manning pipe flow equation.

The pipeline analysis included a 10-year storm for the buildout, land use conditions within the City's current general plan boundaries. For main channel backwater, it was assumed that water surface elevations exhibited full bank channel conditions.

EVALUATION AND PROPOSED IMPROVEMENTS

This chapter presents the results of the capacity evaluation of the storm drainage system. The chapter also presents improvements to mitigate existing system deficiencies and for servicing future growth. These improvements are recommended based on the system's technical requirements, cost effectiveness, and operational reliability.

5.1 PROPOSED IMPROVEMENTS

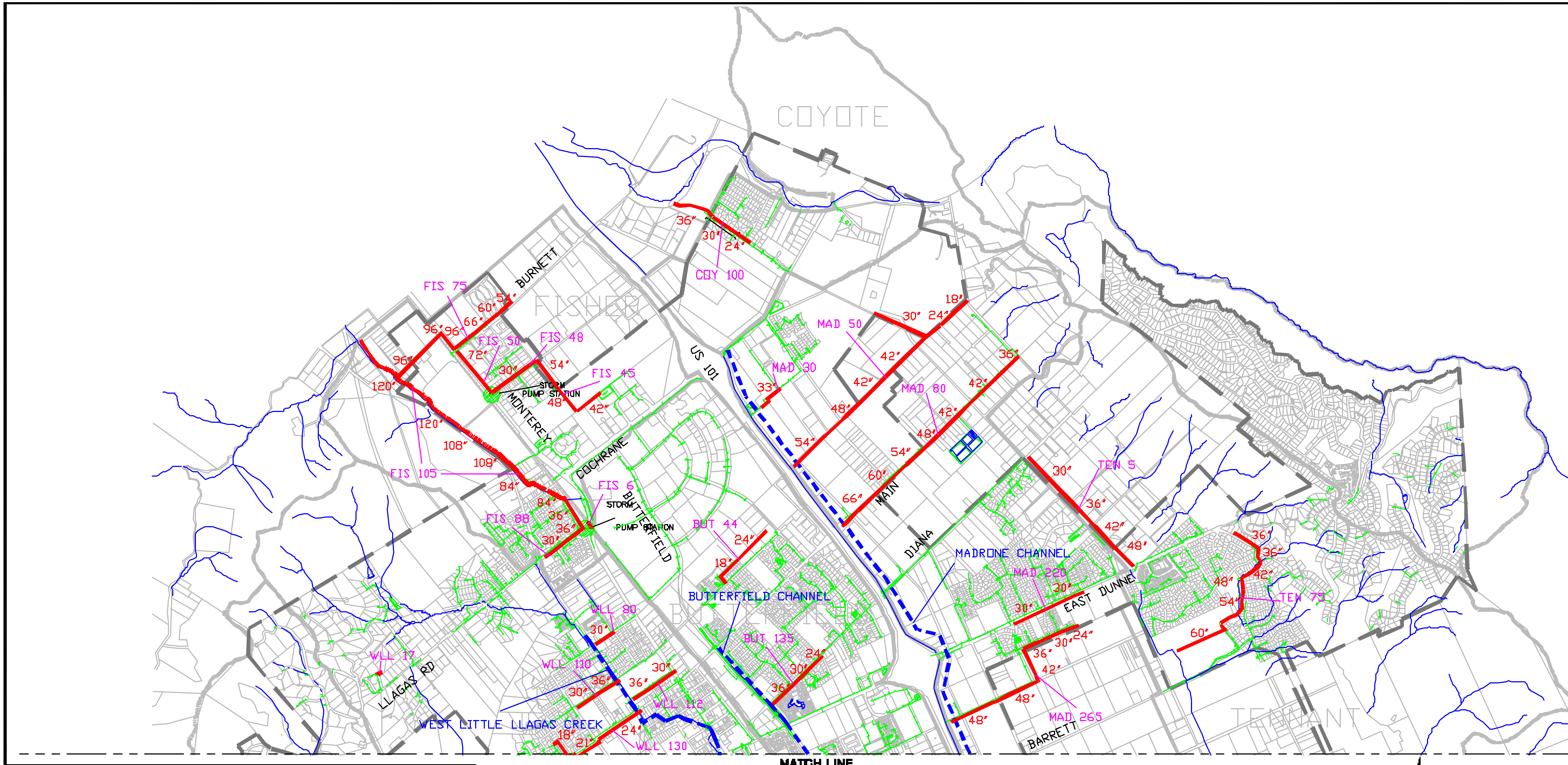
Based on the evaluation criteria discussed in a previous chapter, existing and projected design storms were simulated to evaluate the capacity adequacy of the existing storm drainage system. The recommended improvements discussed in this section are needed to mitigate existing system deficiencies and to accommodate future growth. They are quantified in the Capital Improvement Program (CIP), presented in the following chapter and shown on Figure 5.1.

5.2 MAIN CHANNEL CAPACITIES

Estimates of main channel capacity were calculated based on the as-builts or surveyed channel cross sections and gradients, and were used for routing purposes. It was assumed that 100-year water surface elevations for main channels were between zero and one foot below existing ground level, including the influence of future main channel system improvements. This assumption applied to West Little Llagas, Butterfield, Madrone and Tennant main channels. These water levels were used for establishing the downstream boundary conditions for the modeled storm drainage system.

The analysis indicates that the existing or proposed design capacities for Butterfield Channel, West Little Llagas Creek Channel, Madrone Channel and Tennant Channel will accommodate 100-year design storms for the buildout land use conditions, as established in the General Plan. The analysis also indicates that backwater levels in Llagas Creek and Coyote Creek did not significantly influence the storm drainage system during the 100-year design storm. A preliminary design capacity for Fisher Channel was included in the capital improvements.

As noted earlier in this report, certain main channel improvements were assumed to be completed by 2020. These included improvements to West Little Llagas Creek and Butterfield Channel as presently designed. Butterfield Channel eventually terminates in a retention pond, since the USCOE Llagas Creek flood control plan does not allow for future flow increases from Butterfield Channel. Lower Tennant Creek, outside of the City limits, will eventually require improvement downstream to Llagas Creek.



LEGEND

COY 100	PROPOSED IMPROVEMENT NO.
	EXISTING STORM DRAINAGE PIPELINE
36"	PROPOSED STORM DRAINAGE PIPELINE & SIZE
	MAJOR CREEK/CHANNEL
	EXISTING CREEK
	STORM DRAINAGE BASIN BOUNDARY
	URBAN GROWTH BOUNDARY

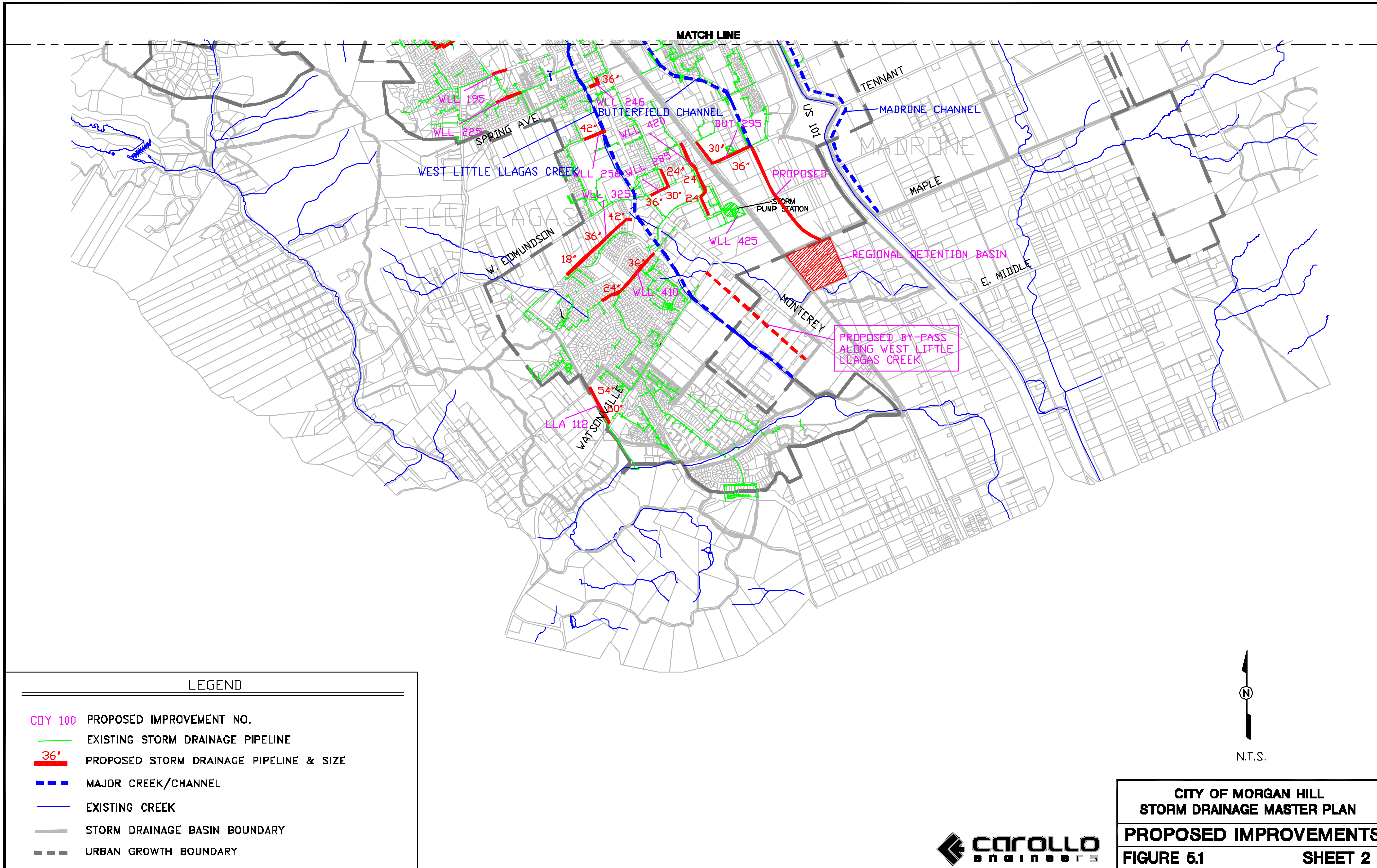
carollo engineers

CITY OF MORGAN HILL
STORM DRAINAGE MASTER PLAN

PROPOSED IMPROVEMENTS

FIGURE 5.1 **SHEET 1**

H:\Client\MorganHill_FNO\8179A.00\10-Reports\StormDrainMasterPlan\MH-Storm924



CITY OF MORGAN HILL
STORM DRAINAGE MASTER PLAN

PROPOSED IMPROVEMENTS

FIGURE 5.1 SHEET 2

H:\Client\MorganHill_FND\5179A.00\10-Reports\StormDrainMasterPlan\MH-Storm924

This improvement needs to be coordinated with SCVWD and may require a retention pond. Lower Fisher Creek requires improvement and coordination with SCVWD at the northern City limit.

5.3 PIPE DRAINAGE SYSTEM CAPACITIES

When evaluating the adequacy of the conveyance facilities, serving existing and future developments, City streets were allowed to flood and provide additional capacity, thus reducing the cost of improvements. Where pipe systems follow City streets, future pipes conform to the 10-year design criteria with excess flow in the street. Storm drainage criteria, also discussed in a previous chapter, allowed city streets to flood up to 1.0 feet above the gutter flow line in the 100-year future design event.

Pipe systems that do not follow City streets had recommended capacities that met the 100-year 2020 flow criteria, without allowance for street overflow. Pipe system capacities were evaluated using either of the Extran model or the Manning's pipe flow equation under the assumption of surcharge by street overflows. The analysis results for the modeled pipe segments are summarized in detail in Appendix A. The appendix lists the existing pipe capacities and the required sizes for meeting 10-year and 100-year storm events.

5.4 INTERIM RETENTION AND DETENTION PONDS

Table 5.1 lists the existing detention ponds. The performance of existing detention ponds was evaluated using the 100-year future land use condition. Table 5.1 lists the routing of 100-year peak flows due to the detention pond facility. Ponds, which provide significant attenuation of design flows, are indicated by the last column of that table.

Most of the detention ponds provided useful 100-year flow storage and attenuation, as shown on Table 5.1. Ponds with attenuation values below 3 cfs did not provide significant storage. Table 5.1 indicates that Pond No. 24 (Table 5.1) required modification to alleviate downstream potential flooding. A larger capacity will mitigate excess street flows downstream in the vicinity of Teresa Lane. A new pond location was required to alleviate both existing and potential flooding in the vicinity of Chargin Drive.

5.5 PUMP STATIONS

There are two existing major active pump stations and one sump pump station in the City's storm drainage system. The first is located at Morgan Hill Business Park (Fisher Subbasin) and pumps to Fisher Channel. The second is at the Concord Circle (West Little Llargas Creek Subbasin) and pumps to Little Llagas Creek. The third pump station empties a sump condition at the Monterey Road railroad crossing. The analysis indicates that the existing pond capacities at both major pump stations are adequate for the 100-year future design condition, except when receiving channels were full.

It is recommended that operational modifications be implemented at both major stormwater pump stations. The City may wish to consider managing the time of discharging back to the stream.

Table 5.1 Detention Ponds Analysis
Storm Drainage Master Plan
City of Morgan Hill

Pond No.	Hydrology Basin	Description	Hydrology Basin No.	Assigned Name	100-YR 2020 HEC-1 Inflow (cfs)	100-YR 2020 HEC-1 Outflow (cfs)	Diff.
1	Butterfield Channel	CAL4 Calle Central	BUT	P41	10	5	5
2	Butterfield Channel	CEN9 El Toro School District	BUT	P43	11	4	7
3	Butterfield Channel	BEN14 Walnut Creek Tract 8234 Private	BUT	P60	15	11	4
4	Butterfield Channel	CAL24 Bells Estate Tract 8485 City Easement	BUT	P83	5	3	2
5	Butterfield Channel	DIA21 Diana Estates Tract 8359 Private	BUT	P90	43	24	19
6	Butterfield Channel	STJ3 St. Joseph Drive	BUT	P130	12	7	5
7	Butterfield Channel	MON24 Woodcrest Estates	BUT	P138	9	4	5
8	Butterfield Channel	DIA 29 Creekside Circle	BUT	P155	28	5	23
9	Butterfield Channel	LAU5 Lyon's Private 58260	BUT	P160	21	10	11
10	Butterfield Channel	WAL6 DBO Private	BUT	P190	46	16	30
11	Butterfield Channel	RIT3 Cottage Green Private 3, 26982	BUT	P200	16	6	10
12	Butterfield Channel	TEN8 Tennant Ave. Private	BUT	P295	30	11	19
16	Fisher Creek	BUT26 Morgan Hill BP Combined- Pump Statior	FIS	P6	399	69	330
17	Fisher Creek	COC16 Sutter Business Park Private	FIS	P10	67	11	56
18	Fisher Creek	WOO3 Cochrane Business Park Private	FIS	P12	74	32	42
19	Fisher Creek	OLD3 Berkshire Chase 13,110 City	FIS	P89	83	73	10
20	Fisher Creek	HAL2 Fox Hollow Tract 8108 City	FIS	P94	17	6	11
21	Llagas Creek	STO3 Stone Gate	LLA	P100	57	27	30
22	Llagas Creek	SKI1 Oak Creek	LLA	P114	16	7	9
23	Llagas Creek	EXC2, Buena Vista Terrace	LLA	P115	34	32	2
24	West Little Llagas Creek	TER1 Llagas Hills Estates Tract 8135	LLL	P17	29	27	2
25	West Little Llagas Creek	CAS22 Castle Hill Tract 7678	LLL	P25	167	163	4
26	West Little Llagas Creek	DAN2 Denali	LLL	P302	19	18	1
27	West Little Llagas Creek	SUN61 Sunset Avenue	LLL	P304	57	54	3
28	West Little Llagas Creek	OLY13 Community Park	LLL	P310	130	39	91
29	West Little Llagas Creek	PIA3 Piazza Way	LLL	P315	19	16	3
30	West Little Llagas Creek	VIA55 Via Castina	LLL	P370	11	8	3
31	West Little Llagas Creek	CON28 Concord Circle- Pump Station	LLL	P425	123	13	110
32	West Little Llagas Creek	VIA4 Hamilton Square Tract 8491 City	LLL	P452	13	7	6
33	West Little Llagas Creek	LAA Mill Creek	LLL	P470	13	6	7
34	Madrone Channel	COC2 Cochrane Road	MAD	P20	77	32	45
35	Madrone Channel	STL9 St. Loise Health Center Private	MAD	P30	111	29	82
36	Madrone Channel	CON3 Diambrosio Tract 8444 City	MAD	P155	10	6	4
37	Madrone Channel	PEA3 Pear Drive	MAD	P168	8	6	2
38	Madrone Channel	EDU8.8 Nordstrom Park	MAD	P208	184	104	80
39	Madrone Channel	CON10 East Dunne Ave. 2	MAD	P216	4	3	1
40	Madrone Channel	HOL1 Holiday Inn Pond	MAD	P226	4	4	0
41	Madrone Channel	PIN1 Pinecone Court	MAD	P229	74	64	10
42	Madrone Channel	PEP10 Vintage Park Tract 8264	MAD	P232	7	6	1
43	Tennant Creek	EDU20 East Dunne Ave.	TEN	P35	20	6	14
44	Tennant Creek	BAR4 Oak Glen Tract 8481	TEN	P127	33	15	18

CAPITAL IMPROVEMENT PROGRAM

This chapter presents the recommended Capital Improvement Program (CIP) for the City of Morgan Hill sewer system. The program is based on the evaluation of the City's storm drainage system, and on the recommended projects described in the previous chapters. The CIP has been staged to the planning horizon year of 2020.

6.1 COST ESTIMATING CRITERIA

The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers experience on other projects. The costs estimated for each recommended facility are opinions included in the Capital Improvement Program (CIP) tables developed with this study. The tables are intended to be used to facilitate revisions to the City's CIP, and ultimately to support determination of the user rates and connection impact fees. Recommendations for cost criteria of pipelines and pump stations are also presented.

6.1.1 Cost Estimating Accuracy

The cost estimates presented in the Capital Improvement Program have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as: preliminary alignments generation, investigation of alternative routings, and detailed utility and topography surveys.

The American Association of Cost Engineers defines three types of cost estimates:

- An Order of Magnitude Estimate for Master Plan Studies. This is an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within +50 percent to -30 percent.
- A Budget Estimate for Predesign Study. A budget estimate is prepared with the use of flow sheets, layouts, and equipment details. It is normally expected that an estimate of this type would be accurate within +30 percent to -15 percent.
- A Definite Estimate (Engineer's Estimate) for Time of Contract Bidding. This estimate is prepared from very defined engineering data. The data includes fairly complete plot plans and elevations, soil data, and a complete set of specs. It is expected that a definite estimate would be accurate within +15 to -5 percent.

Costs developed for this study should be considered "order of magnitude" and have an expected accuracy range of +50 percent to -30 percent. The purpose of this chapter is to present the assumptions used in developing order of magnitude cost estimates for facilities recommended with this master plan. Recommended facility improvements, which will address current deficiencies and facilities required to meet future City needs are presented within the body of the report.

6.1.2 Pipelines

Pipeline improvements to the City range in size from approximately 8-in to 36-inch in diameter. Costs associated with pipelines ranging in size from 8 inches to 36 inches are shown on Table 6.1.

Table 6.1 Pipeline Costs
Storm Drainage System Master Plan
City of Morgan Hill

Pipe Size (inches)	$/Lineal Foot
15	80
18	90
21	110
24	130
27	150
30	160
33	170
36	190
39	210
42	220
46	240
48	260
50	280
54	290
60	300
66	330
72	360
78	390
84	460
90	480
96	510
108	570
120	630
130	670

6.1.3 Pump Stations

Costs associated with new pump station facilities include electrical, instrumentation, pumps, piping, pump station building, and other appurtenances required for a finished pump station. Costs not included are fencing, landscaping, road work, and piling. These items are not known at this time and may be considered a part of the contingency.

6.1.4 Land Acquisition

Acquisition of property, easements, and right-of-way (ROW) will be required for some of the recommended projects, particularly new pump stations. Additionally, the capital costs do not include pipeline corridor purchases or easement costs because it was assumed that public right-of-way will be utilized wherever possible. Land costs in Santa Clara County are not easily determined, particularly in the master planning phase, and variables affecting properties can result in widely varying land prices. Since land acquisition costs are not included in this master plan, the final capital costs may vary from the estimates presented herein.

6.1.5 Construction Cost Index Adjustments

Costs estimated with this study will be adjusted utilizing the Engineering News Record (ENR) construction cost index (CCI). The ENR CCI is the primary index utilized by the water planning and engineering community to adjust cost estimates developed in different years. The costs estimated for facilities with this study are in 2001 dollars, based on an ENR CCI of 7000.

6.2 CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Program for the improvements identified by this master plan are presented in Table 6.2. Care was taken to explain each column, in the previous chapter, additional cost-related explanations are provided herein.

6.2.1 Baseline Construction Cost

This is the total estimated construction cost, in dollars, of the proposed improvement: pipes and pump stations. Pipe Baseline Construction Costs were developed using the following criteria:

- Pipe Unit Cost: Estimated unit cost of pipeline is based on the pipe's present day cost in addition to installation cost, new pavement or pavement restoration, traffic control, bore- and-jack installation (where applicable), mobilization and demobilization, and contractor's overhead and profit. The cost is expressed in dollars per linear foot ($/LF) of pipe length. In the case of jacked steel casings, the unit cost includes the carrier pipe inside the casing.
- Pipe Cost: Estimated cost of the pipeline, calculated by multiplying the estimated length by the unit cost, in dollars.
- Other Infrastructure Facilities Costs: Estimated lump sum costs, in dollars, for the construction of pump stations.

6.2.2 Estimated Construction Cost

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 30 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions.

The Estimated Construction Cost, in dollars, for the proposed improvement consists of the Baseline Construction Cost plus the construction contingency.

6.2.3 Capital Improvement Cost

Other project-related costs have been identified and estimated at 30 percent of the Estimated Construction Costs. These costs include engineering, administration, construction inspection, and legal costs.

The Capital Improvement Cost, in dollars, for each proposed improvement is the total of the Estimated Construction Cost (including contingency) plus the other costs discussed in the previous paragraph.

6.2.4 Capital Improvement Program

The Capital Improvement Program Costs were prioritized based on their urgency to mitigate existing deficiencies and for servicing anticipated growth. The deficiencies in the existing system have a significant total capital cost that is best distributed based on the City's historical ability to construct new infrastructure projects. The City's current capability is approximated at $2,000,000 a year.

The City is capable of allocating larger resources and will perform updated reassessments as needed.

The Program has been divided into the following phases:

- Phase I: This short-term phase includes improvements that are allocated based on annual fiscal budgets between 2002 and 2005.
- Phase II: This intermediate phase includes improvements that are allocated based on a 5-year period between 2005 and 2010.
- Phase III: This long-term phase includes improvements that are distributed based on a 10-year period between 2010 and 2020. Some improvements needed beyond 2020 are also included.

6.3 FUNDING AND FINANCING OPTIONS

Utility rates and connection fees are collected to pay off debt financing, to fund capital improvements and to pay operations and maintenance costs. Connection fees are charges, imposed by local agencies on new developments, for recovering the capital costs of public facilities needed to service those developments. These fees and charges must satisfy the provisions of California Government Code Section 66000 which went into effect on January 1, 1989. These provisions, for water and sewer connection fees, are also known as AB1600 provisions, referring to Assembly Bill 1600 that introduced the provision. The provisions, as they relate to water and sewer connection fees, dictate that the ".... charges do not exceed the estimated reasonable cost of providing the service for which the fee or charge is imposed..."

The improvements in this master plan have been classified into two categories:

- Services benefiting existing development.
- Services necessitated by or benefiting new development.

An opinion of benefit to future users, based on preliminary project information, was included in this master plan. Once estimates for specific projects are completed, a more precise allocation may be performed if required by the provisions of the California Government Code Section 66000 and AB 1600.

New development is defined as any land use change or construction that takes place after the funding procedures recommended in this plan are adopted. Existing development includes properties where no new construction or redevelopment occurs.

Due to state law and political realities, the funding and financing options available differ somewhat for these two categories. Appendix D first presents the funding and financing options applicable to existing developments, followed by those applicable to new developments.

Table 6.2 Capital Improvement Program
Storm Drainage System Master Plan
City of Morgan Hill

No.	Coded No.	Drainage Basin	Type of Improv.	Description/ Street	Description / Limits	Pipeline and App. Costs: Size/ Diam. (in)	Length (ft)	Unit Cost ($)	Pipe Cost ($)	Other Infrastr. Costs ($)	Baseline Constr. Cost ($)	Estim. Constr. Cost[3] ($)	Capital Improv. Cost[4] ($)	Capital Improvement Program: Phase I (2002-2005) 2002-03 ($)	2003-04 ($)	2004-05 ($)	Phase II 2005-10 ($)	Phase III 2010-20 ($)	Financing: Future Users Benefit (%)	Total Capital Cost ($)	Future Users Cost ($)	Existing Users Cost ($)
	Butterfield Channel Basin																					
1	BUT40-A	Butterfield	Pipe	Central Ave.	Calle Central to 945' NE	18	945	90	85,050		85,050	110,565	144,000	144,000					100%	144,000	144,000	0
2	BUT40-B	Butterfield	Pipe	Central Ave.	Serene Dr. to 1050' SW	24	1,050	130	136,500		136,500	177,450	231,000	231,000					100%	231,000	231,000	0
3	BUT135-A	Butterfield	Pipe	Dianna Ave.	Rosemary Ln. to St. Joseph Dr.	24	490	130	63,700		63,700	82,810	108,000	108,000					0%	108,000	0	108,000
4	BUT135-B	Butterfield	Pipe	Dianna Ave.	St. Joseph Dr. to Calle Mazatan	30	525	160	84,000		84,000	109,200	142,000	142,000					0%	142,000	0	142,000
5	BUT135-C	Butterfield	Pipe	Dianna Ave.	Calle Mazatan to Butterfield Blvd.	36	770	190	146,300		146,300	190,190	247,000	247,000					0%	247,000	0	247,000
6	BUT295-A	Butterfield	Pipe	Railroad Ave.	Tennant Ave. to 805' NW	30	805	160	128,800		128,800	167,440	218,000	218,000					100%	218,000	218,000	0
7	BUT295-B	Butterfield	Pipe	Tennant Ave.	Railroad Ave to 430' NE/o Caputo Dr.	36	1,190	190	226,100		226,100	293,930	382,000	382,000					100%	382,000	382,000	0
	Coyote Creek Basin																					
8	COY100-A	Coyote	Pipe	Peet Rd.	Evening Star Ct. to Morning Star Dr.	24	1,225	130	159,250		159,250	207,025	269,000		269,000				100%	269,000	269,000	0
9	COY100-B	Coyote	Pipe	Peet Rd.	Morning Star Dr. to Eagle View Dr.	30	1,120	160	179,200		179,200	232,960	303,000		303,000				100%	303,000	303,000	0
10	COY100-C	Coyote	Pipe	Peet Rd.	Eagle View Dr. to 770' W	36	770	190	146,300		146,300	190,190	247,000		247,000				100%	247,000	247,000	0
	Fisher Creek Basin																					
11	FIS6	Fisher	Telemetry	Pump Only when Capacity Exists in Fisher Creek						20,000					20,000				100%	20,000	20,000	0
12	FIS45-A	Fisher	Pipe	Peebles Ave.	Monterey St. to Clayton Ave.	30	1,610	160	257,600		257,600	334,880	435,000		435,000				100%	435,000	435,000	0
13	FIS45-B	Fisher	Pipe	500' NW of Adams Ct.	Clayton Ave to Woodview Ave	42	805	220	177,100		177,100	230,230	299,000		299,000				100%	299,000	299,000	0
14	FIS45-C	Fisher	Pipe	Clayton Ave.	910' SE/o Peebles Ave. to 1635' SE/o Peebles	48	735	260	191,100		191,100	248,430	323,000		323,000				100%	323,000	323,000	0
15	FIS45-D	Fisher	Pipe	Clayton Ave.	Peebles Ave to 910' SE	54	910	290	263,900		263,900	343,070	446,000		446,000				100%	446,000	446,000	0
16	FIS50	Fisher	Pipe	Monterey St.	Clayton Ave to Burnett Ave.	72	1,575	360	567,000		567,000	737,100	958,000			958,000			50%	958,000	479,000	479,000
17	FIS75-A	Fisher	Pipe	Burnett Ave.	Hacienda Valle to 250' NE/0 Via Feliez	54	630	290	182,700		182,700	237,510	309,000			309,000			100%	309,000	309,000	0
18	FIS75-B	Fisher	Pipe	Burnett Ave.	Birdvale Wy to Hacienda Valle	60	770	300	231,000		231,000	300,300	390,000			390,000			100%	390,000	390,000	0
19	FIS75-C	Fisher	Pipe	Burnett Ave.	Monterey St. to Birdvale Wy.	66	630	330	207,900		207,900	270,270	351,000			351,000			100%	351,000	351,000	0
20	FIS75-D	Fisher	Pipe	Tilton Ave. & Monterey	Burnett Ave. to Tilton Ave then to Monica Dr.	96	2,205	510	1,124,550		1,124,550	1,461,915	1,900,000					1,900,000	100%	1,900,000	1,900,000	0
21	FIS88-A	Fisher	Pipe	Llagas Rd.	Hansen Ct to Berkshire Dr.	30	875	160	140,000		140,000	182,000	237,000					237,000	50%	237,000	118,500	118,500
22	FIS88-B	Fisher	Pipe	Old Monterey Rd.	200' NW/o Berkshire Dr to Llagas Rd. then to	36	1,260	190	239,400		239,400	311,220	405,000					405,000	50%	405,000	202,500	202,500
23	FIS105	Fisher	Channel	Earth Channel	Base=7', S=0.028, Side Slope=30Deg.	84	1,260	350	441,000		441,000	573,300	745,000					745,000	50%	745,000	372,500	372,500
	Llagas Creek Basin																					
26	LLA112-A	Llagas	Pipe	Sunnyside Ave.	630' s/o Sycamore Ave. to Sycamore Ave.	54	630	290	182,700		182,700	237,510	309,000				309,000		100%	309,000	309,000	0
27	LLA112-B	Llagas	Pipe	Sunnyside Ave.	Watsonville Rd to 630' s/o Sycamore Ave.	60	630	300	189,000		189,000	245,700	319,000				319,000		100%	319,000	319,000	0
	West Little Llagas Creek Basin																					
28	WLL17	Little Llagas	Pond	Increase Pond Capacity to 2AF and Increase Pond Outlet to 18"						25,000	25,000	32,500	42,000				42,000		0%	42,000	0	42,000
29	WLL80	Little Llagas	Pipe	Wright Ave.	Hale Ave. to Del Monte St.	30	630	160	100,800		100,800	131,040	170,000				170,000		0%	170,000	0	170,000
30	WLL110-A	Little Llagas	Pipe	Galvan Park	Peak Ave. to Crest Ave.	30	595	160	95,200		95,200	123,760	161,000				161,000		0%	161,000	0	161,000
31	WLL110-B	Little Llagas	Pipe	Galvan Park	Crest Ave. to Hale Ave.	36	665	190	126,350		126,350	164,255	214,000				214,000		0%	214,000	0	214,000
32	WLL112-A	Little Llagas	Pipe	Keystone Ave.	Monterey St. to 100' NE/o Del Monte Ave.	30	700	160	112,000		112,000	145,600	189,000				189,000		0%	189,000	0	189,000
33	WLL112-B	Little Llagas	Pipe	Keystone Ave.	Hale Ave. to 100' NE/o Del Monte Ave.	36	665	190	126,350		126,350	164,255	214,000				214,000		0%	214,000	0	214,000
34	WLL130-A	Little Llagas	Pipe	Dewitt Ave.	W. Main Ave. to 250' before Claremont Dr.	18	700	90	63,000		63,000	81,900	106,000				106,000		0%	106,000	0	106,000
35	WLL130-B	Little Llagas	Pipe	W. Main Ave.	Peak Ave. to Dewitt Ave.	21	1,050	110	115,500		115,500	150,150	195,000				195,000		0%	195,000	0	195,000
36	WLL130-C	Little Llagas	Pipe	W. Main Ave.	Hale Ave. to Peak Ave.	24	1,365	130	177,450		177,450	230,685	300,000				300,000		0%	300,000	0	300,000
37	WLL195	Little Llagas	Curb Inlets	W. Dunne Ave.	Add 50cfs Inlet Capacity (8 Std. Curb Inlets)														0%			
38	WLL225	Little Llagas	Pond	Chargin Dr.	Add 2AF Detention for 100-Year Discharge														100%			
39	WLL246	Little Llagas	Pipe	Spring Ave.	at Monterey Ave.	36	560	190	106,400		106,400	138,320	180,000				180,000		0%	180,000	0	180,000
40	WLL256	Little Llagas	Pipe	Cosmo Ave.	Del Monte Ave. to Channel	42	700	220	154,000		154,000	200,200	260,000				260,000		0%	260,000	0	260,000
41	WLL285-A	Little Llagas	Pipe	Church St.	E. Edmundson Ave. to Tennant Ave.	24	560	130	72,800		72,800	94,640	123,000				123,000		0%	123,000	0	123,000
42	WLL285-B	Little Llagas	Pipe	Tennant Ave.	Church St. to 315' west	30	315	160	50,400		50,400	65,520	85,000				85,000		0%	85,000	0	85,000
43	WLL285-C	Little Llagas	Pipe	Tennant Ave.	315' w/o Church St. to west	36	350	190	66,500		66,500	86,450	112,000				112,000		0%	112,000	0	112,000
44	WLL325-A	Little Llagas	Pipe	s/o W. Edmundson Ave	McKelvy Ln. to 840 ft. east	18	840	90	75,600		75,600	98,280	128,000				128,000		100%	128,000	128,000	0
45	WLL325-B	Little Llagas	Pipe	s/o W. Edmundson Ave	840' e/o McKelvy Ln.	36	700	190	133,000		133,000	172,900	225,000				225,000		100%	225,000	225,000	0
46	WLL325-C	Little Llagas	Pipe	s/o W. Edmundson Ave	Easement	42	1,085	220	238,700		238,700	310,310	403,000				403,000		100%	403,000	403,000	0
47	WLL410-A	Little Llagas	Pipe	La Crosse Dr.	La Baree Dr. to Alameda Dr.	24	630	130	81,900		81,900	106,470	138,000				138,000		0%	138,000	0	138,000
48	WLL410-B	Little Llagas	Pipe	La Crosse Dr.	Little Llagas Creek to La Baree Dr.	36	1,540	190	292,600		292,600	380,380	494,000				494,000		0%	494,000	0	494,000
49	WLL420	Little Llagas	Pipe	Vineyard Blvd.	Vineyard Ct. to Concord Cricle south	24	1,890	130	245,700		245,700	319,410	415,000				415,000		0%	415,000	0	415,000
50	WLL425	Little Llagas	Telemetry	Install Pump Controls. Pump When Capacity Exists in Little Llagas Creek						20,000	20,000	26,000	34,000				34,000		0%	34,000	0	34,000
	Madrone Channel Basin																					
51	MAD30	Madrone	Pipe	Orthogonal to St. Louis	St. Louis Dr to 1440' SW/o Mission View Dr.	33	1,050	170	178,500		178,500	232,050	302,000					302,000	50%	302,000	151,000	151,000
52	MAD50-A	Madrone	Pipe	Half Rd.	Coyote Rd. to 490' SW	18	490	90	44,100		44,100	57,330	75,000					75,000	100%	75,000	75,000	0
53	MAD50-B	Madrone	Pipe	Half Rd.	200' NE/o Walizer Ln. to 490' SW	24	560	130	72,800		72,800	94,640	123,000					123,000	100%	123,000	123,000	0